Eco-Industrial Development:
Eco-Industrial Parks, Bio-Refineries, Renewable Energy, and Zero Waste Opportunities for Lane County

A Report for the Lane County Sustainable Business and Jobs Project
October 10, 2003

Prepared by UO Graduate Student Interns
Naoko Atsusaka, Kate Darby, and Tim Shinnebarger
with assistance from Tom Osdobo and Faculty with the
Program for Watershed and Community Health
Institute for a Sustainable Environment
University of Oregon
346-0687
cwch@darkwing.uoregon.edu

Background and Acknowledgments

As we enter the new millennium, the residents of the Southern Willamette Valley face a number of important economic, social, and environmental challenges. The economy is struggling, unemployment is high, government revenues are falling, and water quality, fisheries, and other environmental resources are at risk. Decision makers seek appropriate steps to resolve these problems in a manner that will simultaneously enhance the economy, workers, and the environment, but often are unclear about how to achieve these multiple goals.

In the winter of 2003, the Program for Watershed and Community Health (PWCH), a research and technical assistance program affiliated with the Institute for a Sustainable Environment at the University of Oregon, initiated a project to help decision makers throughout the southern Willamette Valley understand sustainable business and job development and identify strategies to secure and expand the local sustainability sector. The PWCH seeks to provide accurate, objective, and easy-to-understand information about the size and scope of the existing sustainability sector. It seeks to assess the potential costs and benefits associated with expanding the sector and assisting others to adopt sustainable practices. A team of seven graduate students from the Department of Planning, Public Policy, and Management at the University of Oregon served as the research staff for the project. An informal group of local government and economic development specialists served as the steering committee for the project. This report is one of a series of reports to be produced as a result of this effort.

AUTHORS

Naoko Atsusaka, Kate Darby, and Tim Shinnebarger developed this report with assistance from Tom Osdobo of 4ePartners. Bob Doppelt, director of the Program for Watershed and Community Health, supervised the overall project.

ACKNOWLEDGMENTS

The PWCH gratefully acknowledges the financial support of the Ford Foundation, New Land Foundation, and the City of Eugene for this project.

Table of Contents

ECO-INDUSTRIAL DEVELOPMENT: OPPORTUNITIES FOR LANE COUNTY
Executive Summary

This report outlines business and job opportunities for Lane County, Oregon, in the diverse field of *Eco-Industrial Development.* The research and writing was completed by a team of graduate student interns from the University of Oregon, along with Tom Osdobo from E4Partners, working with faculty and staff from the UO Program for Watershed and Community Health. In specific, the report assesses the potential to expand, incubate, or recruit businesses and engage civic and government organizations in the development of eco-industrial parks, bio-refineries and bio-based industrial systems, renewable energy systems including biomass, biofuels, hydrogen fuel cells and solar, and zero waste (waste free) programs.

Eco-industrial development is in some ways a very old economic model—yet in other ways it is a new paradigm for achieving superior business and government performance. Renewable forms of energy were widely used in the U.S. through the first part of the past century. Up through the early 1940s, almost everything produced in the U.S. was reused and recycled. In many ways Eco-industrial development simply builds upon our early patterns. By using renewable forms of energy, using resources much more efficiently, and by establishing linkages among local *natural* resources as well as local *human* resources, Eco-industrial development creates value by continually recirculating energy and materials through the economy and creatively fostering dynamic and responsible growth.

Eco-industrial development involves reducing and eliminating, whenever possible, toxic substances (such as fossil fuels) and bioaccumulative substances (such as many human-made chemicals) in products and processes from the onset, rather than attempting to filter them out at the end, as traditional environmental programs seek to do. When no harmful substances are used or generated, there is no need for government regulation. Also, materials contaminated with toxic substances cannot be easily reused in new products or services. If toxic materials and substances must be used in the short-term for lack of acceptable substitutes, a strategy would be devised to ensure that they are completely sequestered and continually reused within technical industrial cycles and not allowed to dissipate into nature.

Using case studies, information gathered from leading local and national experts, and extensive web research, this report found significant potential for expanding existing businesses and incubating and recruiting new ones in Lane County in the field of Eco-industrial development. Numerous suggestions are offered for initiating and capturing these opportunities. One of the common themes found throughout the recommendations is the need for local and state government, business, civic, and academic leaders from throughout the county to form partnerships aimed at expanding their understanding of the opportunities and developing business and job development strategies. Business and job opportunities in the field of eco-industrial development are growing rapidly across the globe. Lane County could become a center of excellence in this exciting new field with sufficient attention and proper focus. In doing so, the citizens and communities of Lane County would achieve significant economic, social, and environmental benefits.

ECO-INDUSTRIAL DEVELOPMENT: OPPORTUNITIES FOR LANE COUNTY

I. INTRODUCTION

This document discusses a number of business and job opportunities in the diverse field of *Eco-Industrial Development.* Business and job development are always challenging. Economic development is especially challenging in today's climate. As the global marketplace has become increasingly competitive, local, state, and regional governments seek new strategies for attracting or incubating new businesses and expanding existing businesses that are good investments and provide living-wage jobs. Moreover, citizens across the Northwest continue to demand conservation and improvements in the local environment. In the past, the tradeoffs seemed obvious - economic development and environmental protection were viewed as mutually exclusive. However, new understandings, technologies, and practices are debunking that assumption. One broad category of business and job opportunities that generates economic, social, and environmental benefits is called Eco-industrial development.

Eco-industrial development is in some ways a very old economic model—yet in other ways it is a new paradigm for achieving superior business and government performance. Renewable forms of energy were widely used in the U.S. through the first part of the past century. Up through the early 1940s, almost everything produced in the U.S. was reused and recycled. There was little waste because the cost of extracting and refining resources and manufacturing products was too high to discard valuable materials with no economic benefit in return. In many ways Eco-industrial development simply builds upon our early patterns. By using renewable forms of energy, using resources much more efficiently, and by establishing linkages among local *natural* resources as well as local *human* resources, Eco-industrial development creates value by continually recirculating energy and materials through the economy and creatively fostering dynamic and responsible growth.

II. PRINCIPLES OF ECO-INDUSTRIAL DEVELOPMENT

Our current economic system is fundamentally linear in nature. It focuses on producing products and delivering them to the customer in the fastest and cheapest way possible at maximum profit. Not much else matters. We extract resources from the Earth's surface and turn them into goods. We then discharge massive amounts of often highly toxic waste this system generates (including waste from the industrial system and waste from end-of-life products) back into nature. This straight-line approach has been called a "take-make-waste" or "cradle to grave" economic model.[1]

Underlying problems with the linear economic model create troubles that are now becoming apparent. The Earth's air, forests, oceans, soils, plants, and animals do not have the capacity to supply increasing amounts of resources nor can nature absorb all of society's pollution and waste. Workers, communities, and whole cultures are also increasingly unhappy about the harm to their environment and way-of-life that the linear take-make-waste model can generate.

Eco-industrial development is an alternative to the traditional economic model. At its core, it fundamentally transforms the linear paradigm into one that is *circular* in nature. This can be

considered a “borrow-use-return” system[2] or, as design expert Bill McDonough calls the new paradigm, a "cradle to cradle" production model.[3] Guided by the principal found everywhere in nature that "waste equals food," this approach focuses on rethinking energy systems, processes and products (from buildings, to manufacturing systems, to consumer goods and transport systems) from the outset so that extraction, transport, and production are benign or even restorative so that materials continually recirculate in industrial systems or in the biosphere without producing harm to the environment, public health, or quality-of-life. “Products can either be composed of materials that biodegrade and become food for *biological cycles*, or of technical (sometimes toxic) materials that stay in closed-loop *technical cycles*, where they continually circulate as valuable nutrients for industry.”[4]

To make the transition to the circular borrow-use-return model, Eco-industrial development involves eliminating, whenever possible, toxic substances (such as fossil fuels) and bioaccumulative substances (such as many human-made chemicals) in products and processes from the onset, rather than attempting to filter them out at the end, as traditional environmental programs seek to do. When no harmful substances are used or generated, there is no need for regulation. Also, materials contaminated with toxic substances cannot be easily reused in new products or services. If toxic materials and substances must be used in the short-term for lack of acceptable substitutes, a strategy would be devised to ensure that they are completely sequestered and continually reused within technical industrial cycles and not allowed to dissipate into nature.

The shift to the circular borrow-use-return approach also involves transitioning to renewable sources of energy such as solar, biomass, or hydrogen when possible; designing products to be easily disassembled so they can be easily taken apart, reused or recycled; using local raw materials when possible; and establishing the physical infrastructure to facilitate the continual recirculation of materials and substances (i.e. redesign waste disposal systems into materials exchange systems).[5]

In sum, Eco-industrial development seeks to mimic nature. Nature has no waste. Wherever we look in nature we see interconnected systems that work with each other to insure survivability and efficient use of resources and energy. This observation is also true in the business world. Strategic partnerships, networked manufacturing, and preferred supplier arrangements are examples of ways businesses insure their growth, contain costs, and reach for new opportunities. Eco-industrial development seeks to mimic nature as much as possible by expanding the way public and private organizations use, exchange, and recirculate energy and material resources.

III. PRACTICAL APPLICATIONS

For most businesses, the three essentials for success are access to cost-effective, quality energy and resources for producing and delivering products and services, efficient use of those resources and capital, and responsive markets. Absent these factors virtually every other incentive becomes a minor consideration.

Eco-industrial development looks systematically at business, government, and civic organizations as well as local environmental resources to identify the natural linkages between one or more of the entities. On one level, it is as directly practical as making direct exchanges of the industrial by-products and end-of-life products generated by one organization (resources we now call waste) and the feedstocks needed by another for production. Of course, to make this

type of exchange system feasible, toxicity must be designed out of products and processes because contaminated feedstocks usually cannot be used by other organizations. In addition, the materials must be easily disassembled to facilitate recirculation.

At another level, Eco-Industrial development is a whole new way of using resources and energy flows at much higher levels of efficiency and effectiveness. For example, rather than just producing agricultural crops for global commodity markets, and therefore being controlled by the whims of international market forces, an Eco-Industrial development approach would diversify the economic base by pursuing crops that can be turned into emerging high-end bio-based niche products (such as bio-lubricants).

Eco-industrial development can be applied in numerous ways. One starting point is for each local organization to use energy, water, and raw materials at significantly higher levels of efficiency. Higher performance is often initially achieved through internal audits that pinpoint the greatest opportunities for improved resource efficiency. The potential for increased efficiency is great. The American Society of Engineering estimates that the U.S. is only about 2 to 3-percent efficient in our use of energy and resources. Americans waste, or cause to be wasted, nearly one million pounds of materials per person each year. About 93-percent of what is produced in our economic system is waste and only 7-percent ends-up in products. Ample evidence shows increasing efficiency reduces operating costs and improves overall productivity.

While extremely beneficial, improved resource efficiency is but a basic building block for broader Eco-industrial development efforts. A next step is to explore the potential for expanding the use of renewable energy and to identify how local natural resources are currently used. Mapping the extent to which materials are exchange between local organizations is helpful to assess current resource use. Cluster analysis of existing industries may facilitate these understandings. This process may lead to some obvious and some less obvious but potentially lucrative business and job opportunities. For example, new and higher uses for existing agricultural crops, forest products, metals, and naturally occurring resources may be identified. New or higher value uses for the industrial by-products and end-of-life products generated by local organizations may be also identified.

Once existing organizations have taken steps to utilize energy and materials more efficiently, the potential for renewable forms of energy are considered, and cluster analysis is completed, the next step is new business development. One approach is co-location of businesses that seek to share resources such as heat and energy, exchange by-products whereby the materials generated by one entity are used as feedstocks by another, or exchange ideas and technologies to create even better products. Eco-Industrial parks and business incubation centers have been found to be helpful ways to achieve these goals. A more narrow variation of this approach is a community-wide materials exchange whereby organizations trade industrial by-products and end-of-life products through local Web-based materials exchanges or through other mechanisms. BRING Recycling in Lane County has such a system.

The greatest Eco-industrial development opportunities are found by increasing inter-connections between local companies, civic organizations, and government. Variations occur based on the kinds of issues on the table, the natural and market ecology, and how closely businesses are willing to work together for their mutual advantage.

IV. BUSINESS AND OTHER BENEFITS

Public and private organizations across the globe that have adopted the Eco-industrial development approach are finding major cost savings and reduced social, public health, and environmental risks. Many are generating new products, expanding market share, and in other ways finding increased competitive advantage.

The motivation for a company to invest in a new location or expand locally is based on a number of factors. When planning marketing strategies or recruiting, Eco-industrial development focused communities can target companies or industries that display many of the characteristics described above. Any one of these characteristics is sufficient to encourage development by itself but a combination greatly expands the potential. Imagine a business prospect that wants access to Lane County or regional markets, uses agricultural lands for crops that can be turned into high-end non-food ag products (such as industrial lubricants), or uses materials found in our waste stream, and has demonstrated its commitment to environmental excellence through participation similar efforts elsewhere. This would be a perfect candidate.

Though most prospects come in shades of gray, communities following an Eco-Industrial development model look for a commitment to measurable continuous business, social, and environmental improvement. Communities throughout Lane County could promote these principles to attract entrepreneurs and investors. Incentives, technical assistance, and other services from local governments and economic development agencies may also be tailored to enhance other factors. Clean high performance companies seek these locations for the simple reasons of fewer environmental liabilities, an enhanced public and market image, and higher financial performance, especially return on assets. It's a winning combination.

Eco-industrial development works because it consciously mixes a range of targeted strategies shaped to the needs and attributes of the community. Most importantly, it can work because communities throughout Lane County want nothing less than the best possible businesses in or near their neighborhoods. For companies, it provides a path towards significantly lower costs, higher operating results, and positive market presence. For workers it provides healthy, stable, well-paid employment. For the environment, it provides a way to transform waste into valued products and to make stewardship a joint pledge of both businesses and communities.

V. POTENTIAL ECO-INDUSTRIAL DEVELOPMENT OPPORTUNITIES IN LANE COUNTY

A. ECO-INDUSTRIAL PARKS AND BUSINESS INCUBATORS

Sustainable small businesses and new technology startups provide an alternative way to grow economies. Industrial zones or specific business incubation and development facilities can provide the critical support structures needed to link these organizations to the capital, markets, energy and raw material flows, innovative ideas, and research needed for their growth. Eco-industrial parks also have multiplier effects that help existing and new small business growth. The President's Council on Sustainable Development (PCSD) promoted this concept by designating four eco-industrial park demonstration sites: Baltimore, Maryland; Cape Charles, Virginia; Chattanooga, Tennessee; and Brownsville, Texas. Other parks and business development centers have blossomed across the U.S. on their own since that time.

The foundation of eco-industrial development is an interconnected system of firms within an industrial park or region. It emphasizes exchanging energy, materials and by-products between organizations: in essence, the waste by-products emitted by one entity become the raw materials or energy supply of other companies. If one organization can use another's industrial by-products as a resource, it requires less virgin material extraction, transportation, or energy for its own production process. The company that sells its industrial waste products, meanwhile, receives revenue for them rather than pay tipping fees for their disposal. By applying these principles to a network of organizations, natural resources can be conserved while costs are reduced along with energy and water use and industrial waste. A systems approach to managing local industrial activity creates opportunities for organizations that recover, refine and reuse industrial by-products. In a community development context, these aspects can mean opportunities to invest in new jobs, better training, and improved environmental management practices.[6]

According to a document prepared for the U.S. Economic Development Administration, the benefits of eco-industrial parks can include economic efficiency and profitability, job retention and growth, community development, and environmental stewardship. The EPA report lists four risks. Risks may be financial – a potentially longer payback period may make the financial community reluctant to support projects. Companies may consider the interdependence between companies involved in by-product exchange a risk. The existing federal regulatory structure may pose obstacles. Lastly, by-product exchange may encourage continued reliance on toxic materials and may discourage technological innovation.[7]

Eco-industrial development requires an *information management system* to compile data on the system-wide resource flows of member companies and organizations. By assessing the inputs, outputs and energy use of organizations, material and by-product exchanges can be identified. A coordinating organization can also compile regional data and identify potential materials exchanges between companies. The greater the number of companies involved, the greater the likelihood specific companies can exchange input or output materials. Large cities have the requisite volume of material for cost-effective resource recovery and exchange. Small communities may not. Eco-industrial development practitioners in Lane County might increase their options by linking with IMEX, the Industrial Materials Exchange based in Seattle, and with other business exchange networks.

Like any development, eco-industrial development takes place within the context of a community. Effective *public involvement* processes allow businesses and community stakeholders to cooperate in generating development alternatives.[8] The community can work to strengthen its economic base, shape its future, improve quality of life, and maintain natural assets by pursuing a comprehensive economic development plan that fits the region's workforce, ecosystem, institutions, and resources. The Devens, Massachusetts's case study that follows is an example of how the process can play out.

The Devens, MA. Example

Faced with the closure of the Fort Devens, Mass., military base, four surrounding towns and the Commonwealth of Massachusetts formed the Devens Regional Enterprise Zone. The Devens Enterprise Commission guarantees development permitting applications will be acted upon within 75 days.[9] Devens includes an Environmental Business Zone (EBZ). A key component of the EBZ is to provide material and by-product exchanges between companies. In one case, a producer of tofu and soy products had a biochemical oxygen demand (BOD) surcharge problem that cost it $100,000 per year. The producer now dries its waste stream and sells it to a pet food manufacturer. It converted a waste stream into a revenue stream.[10]

Devens is developing an eco-industrial park based on its existing industries. It is analyzing energy, material, and water flows. As the flow analysis reveals gaps, the Devens board will recruit appropriate businesses to the park that can utilize the waste materials produced by others. Meanwhile, it will recruit customers for existing energy, material, and water flows. Major material flows include corrugated cardboard, paper, plastic, metal scrap and chips, wooden palettes, and machine oil. The emphasis for the Devens eco-industrial park will be on attracting new industries and integrating principles of industrial ecology in their processes from the beginning. As an illustration of scale for comparison with Lane County industry, Devens currently has six industrial areas and 75 companies.

The Environmental Business Zone has language in its definition that addresses by-product or material exchanges. Staff at the EBZ said that in 1994 when the language was written it lacked the clarity that would be included if it were adopted today. However, the board has decided not to change the bylaws.

The Environmental Business Zone is located on the north post near the wastewater treatment facility, which was viewed as providing potential for various exchanges. The state economic development agency, Mass Development, offers a large array of incentive programs for Devens ranging from Foreign Trade Zone Designation, to various loans and training programs. Firms that are not interested in by-product exchanges are welcome. Material exchange is a voluntary program. However, EBZ staff said they don't do as well as those that choose to participate in some of the sustainability programs.

The Philips Eco-Enterprise Center, Minneapolis, MN

The Philips Eco-Enterprise Center was built as an alternative to a garbage transfer station that was proposed for a low-income, ethnically diverse neighborhood. Local residents who felt it would only add to the depressed conditions of the area vigorously opposed the transfer station. Local residents who wanted a positive solution for the controversial site developed many of the

design ideas of the Center. The site was an urban brownfield that had been contaminated with arsenic that the PEEC helped to remediate.

Costs vs Benefits of PEEC Building Design

- Simple payback = 2.5 years
- Capital costs increased by $168,000
- $3.00/ft or 4% of overall budget
- Combined owner/tenant savings
- Revenue of > $60,000 per year
- Increased Rents
- 5 to 10% above market
- Internal Rate of Return = 39%

Markey Acceptance

- PEEC is full and operates at a profit
- 150 jobs in neighborhood, including many targeted to neighborhood residents
- Positive reception from businesses and workers
- Strong interest from energy & environmental firms & non-profits
- Local, national & international awardsTremendous visibility and source of pride

PEEC As a Catalyst in the Community

- Influence on urban redevelopment throughout Phillips neighborhood and City
- New urban energy cooperative with combined heat & power project (biomass)
- Design of $200 million in new projects in area resulting from PEEC
- Neighborhood-oriented service/retail, transit area growth
- Substantial growth of affordable housing
- Neighborhood wants to keep industry
-

Summary of Benefits of the Phillips Eco-Enterprise Center

Business Benefits

- 150 jobs, 35 new ones for residents
- Annual budget of $3.5 million
- 3 commercial banks bid on financing
- 15 tenet companies within a year of opening

The Zero Emissions Brewery, Namibia, Africa

Another interesting example of Eco-Industrial development is the Zero Emissions Brewery in Namibia developed by the United Nations Zero Emissions Research Initiative. This project integrates a brewery, an aquaculture facility, and an agriculture system in a rural area to produce beer, food, clean water, and jobs.

Use Less Resources and Energy

- Methane from an on-site bio-digester is used as energy source.
- Biodiversity of fish species, instead of machines is used to aerate water in fish ponds.

Use Resources and Energy Efficiently

- Brewery waste-water is used to wash pig pens.
- Fish ponds are used for growing hydroponic crops.

Re-circulate Resources

- Sewage and other wastes are fed to bio-digester to produce methane.
- Mineralized water from the fish ponds used to irrigate and fertilize fields.
- Spent grains from brewery are used as growth medium for edible mushrooms, earthworm production, and fed to livestock.
- Spoilt brew returned from market is fed to the bio-digester and its' packaging is fed to livestock.

The Potential for Eco-industrial Parks in Lane County

Because its focus is on a coordinated and integrated system that balances company and community interests, eco-industrial parks require a clear method of accountability at the community, agency and company levels.[11] Potentially, a local community (such as Oakridge with its industrial park), Lane County, or an economic development agency could take the lead role. A public-private partnership could also lead.

One key step that must be taken to promote eco-industrial parks is a clear declaration of intent. An explicit goal must be declared of establishing a site with the specific purpose of incubating, growing, and recruiting organizations that agree to apply principles of eco-industrial develeopment and exchange energy resources and waste materials.

Once the goal has been established, potential sites can be examined. In addition, potential incentives to lure or retain businesses can be identified. Marketing and promotional strategies can also be developed.

The level of planning, information gathering and coordination involved may be extensive. Rather than develop an entire knowledge base from scratch, Lane County communities might seek outside expertise. One possible approach is to request that the Governor's Community Solutions Team provide the expertise, write up a plan, and provide start-up funding. Other potential partners include the local Chambers of Commerce, the Lane Economic Committee, Oregon Department of Community and Economic Development, and Lane Metro Partnership. Partners that could provide expertise, research and, possibly, research assistance at an internship level, include the University of Oregon Charles H. Lundquist College of Business, the UO Program on Watershed and Community Health, Lane Community College, and other programs and institutions. Maintaining eco-industrial development efforts will require all levels of government and the private sector.

B. BIO-REFINERIES AND BIO-BASED INDUSTRIAL SYSTEMS

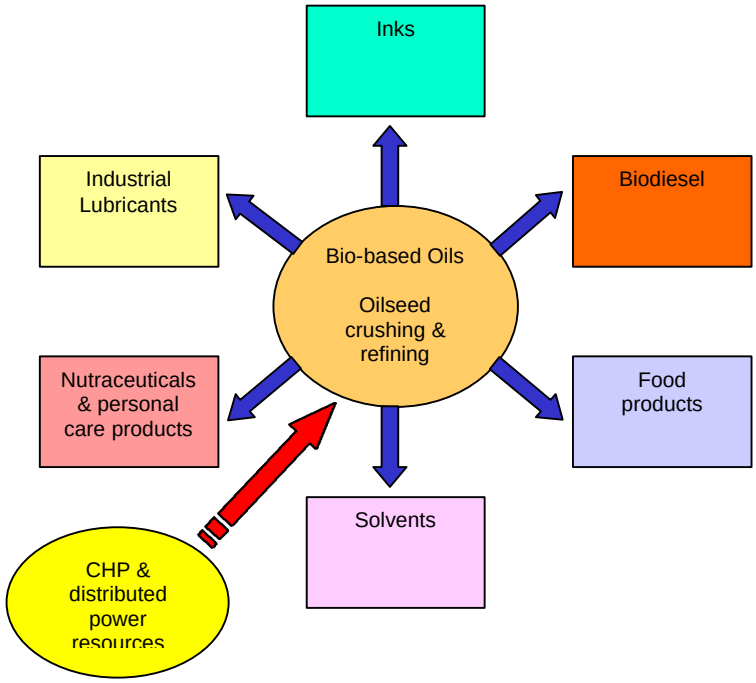
Non-food agricultural products can become a major crop for farmers in Lane County and new products can be manufactured by developing small-scale "bio-refineries" that turn organic materials into bio-based products. Bio-based fuels (grain or biomass ethanol, oilseed biodiesel, biomass methanol, commercial cooking oil biodiesel), lubricants (motor oils, total loss lubricants, hydrolic fuels), nutraceuticals, chemicals, composites, building materials, textiles, corn-based plastics, and paper are just some of the bio-based products that could be produced in the southern Willamette Valley. Grains, oilseeds, and biomass such as wheat straw and grass seed, as well as local crops such as canola and mustard could provide the feedstocks for the bio-products.

Bio-Based System are Growing in the Northwest and Lane County Could Participate

The Washington Department of Ecology in September 2003 approved Pacific Rim Ethanol LLC's air quality permit, which was the last regulatory hurdle, for beginning construction on a $122 million ethanol plant in central Washington. In September of 2003, Oregon Governor Ted Kulongoski successfully pursuaded Treaure Valley Renewable Resources to locate its state-of-the-art biorefinery in the rural, eastern Oregon town of Ontario, rather than across the Snake River in Idaho. The $77 million Renewable Resources Plant is slated to produce fuel-grade ethanol, as well as starch, fiber and protien ingredients for human dietary products. It is expected to be fully operational within 16 months.[12] Lane County has the opportunity to develop similar bioproduct based industries and products. This opportunity is centered on a few key points:[13]

- The market for using bio-based industrial lubricants should be expected to grow over the next 5-10 years, and can be driven in the early stages through public sector and environmentally oriented end users.
- Production of oilseed feedstock in the region is low at present, but can expand to meet the needs for an appropriate scale crushing and refining operation.
- Area farmers can consider several approaches to cooperating to pursue this opportunity, in order to capture the value-added benefits.

The graphic below illustrates the array of value-added opportunities in a bio-refinery related to oilseed production. Our research found that the first priority for consideration in Lane County would likely be industrial lubricants, with a secondary focus on nutraceuticals. These products are emerging in the marketplace and production is more readily available to small and medium production operations. Inks, biodiesel and food products are already being produced in large quantities. Further, industrial lubricants have been produced most effectively with canola (or rapeseed, which can be grown outside of the Willamette Valley) feedstocks, in keeping with their European origins. Meadowfoam represents another oilseed, suitable for production in the Willamette Valley, but with applications in personal care products (nutraceuticals).



Pursuit of these opportunities would most likely come about through a new venture, which would then negotiate an agreement with one of several product developers looking to introduce these products into diverse markets in North America. Agreement scope would focus on licensing technology for an agreed-upon array of products. In addition, this development enterprise is compatible with other production opportunities, including biodiesel, solvents and nutraceuticals, which are described separately as part of this project summary. In the short term, biodiesel may be considered as a complimentary production element and developed simultaneously with lubricants production.

A successful enterprise will have to devote a fair amount of attention to the marketing aspects of these products. Factors such as customer awareness of performance benefits, government procurement commitments, and level of support for local enterprise are among the many issues that can influence the success of this type of venture, especially in the initial stages. Any new venture will need to be able to put forth an effective marketing operation to support the production efforts.

Business Development Opportunities For Bio-Based Lubricants

Production, marketing and distribution of bio-based lubricants represents a near term opportunity throughout North America. This summary provides background information on bio-based lubricants along with specific discussion of concrete steps that can lead to a development project. [Acknowledgement: Industry data presented in this section is presented in *Lubricants from Vegetable Oils*, produced by The Carbohydrate Economy and the Institute for Local Self-Reliance. Original data sources are cited where appropriate.]

Bio-based lubricants, made primarily from canola oil, but can be produced using soybean, sunflower and safflower oils, can be used in several applications:

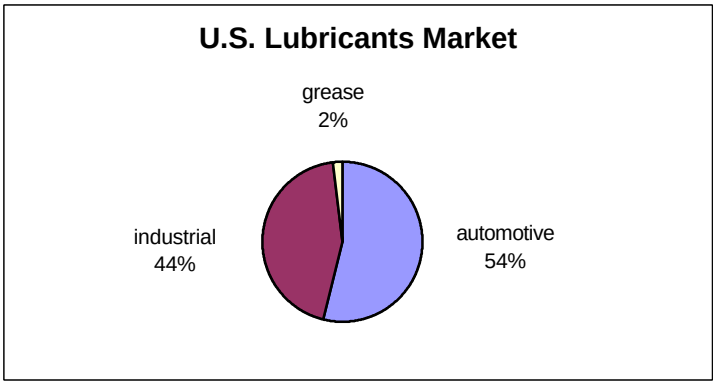
- *Hydraulic fluids* – used in turf mowers, tractors, forklifts, and front-end loaders.
- *Total loss lubricants* – two-stroke engine oil used in lawnmowers, snow blowers, and boats, chainsaw bar and chain oil, railroad flange oil and grease, drip oil, wire rope lubricant and dust suppressants.
- *Automotive lubricants* – used in engine crankcases.

Currently, oilseed production in Oregon is small. Canola is grown in small quantities, and represents the most promising feedstock for short-term considerations. This is because many of the original product technologies were based on canola oil formulations and because Canola can be grown in Oregon. If local production of Canola is slow to come about, abundant quantities of Canola could be secured from eastern Washington.

Beyond the oil applications, this business development opportunity includes ancillary resource uses. Crushing operations produce residual meal that is a marketable high-protein animal feed, and may have other value-added uses. Residual plant waste may be usable as biomass, either directly for energy production or through gasification into a refined fuel. These market options should be considered in tandem with the primary end use of the seed oils.

Lubricants Markets in the United States

Recent market figures from the National Petrochemical Refiners Association show the industrial lubricant market to be 2.7 billion gallons in 1997. As illustrated in the figure below, nearly all of the market is split between automotive and industrial uses.



Lubricants produced and used in the U.S. are almost all petroleum-based, comprising over 90 percent of the market. Synthetic lubricants are estimated at about three percent in 1999, about 75 million gallons, and vegetable-based lubricants are less than one percent (Kline & Company, 1999). A portion of the synthetic products, ranging from a third to half, is considered biodegradable. Industry data indicate steady growth in production of biodegradable lubricants, estimated at about seven percent for 2000. Both bio-based and synthetic lubricants should experience growth, as biodegradable products become more common substitutes for those derived from petroleum (Frost & Sullivan, 1999).

Several companies have introduced bio-based lubricant products into the commercial marketplace. Many of these companies are still involved in product development work, and considering options for growing into production level operations. Based on the success they have had to date, the most promising end users include:

- *Natural areas, parks, forest lands,* including existing operations:
    - Ohio Department of Natural Resources;
    - Virginia Department of Forestry;
    - Yosemite, Yellowstone and Olympic National Parks; and
    - Minnesota Department of Natural Resources (trial use underway).
- *Golf courses,* already including courses in several states (New York, Vermont, Massachusetts).
- *Owners/operators of marine motor craft*, both in commercial and personal use.

Government direction and policy are encouraging greater use of bio-based lubricants. Several Executive Orders were enacted during the Clinton Administration to expand government use of bio-based products, including lubricants, through government procurement and financial incentives for product development. At the state level, Iowa and Michigan have enacted similar policies, and several other states have considered measures. These measures have endured into the Bush Administration.

Product Performance and Cost

Bio-based industrial lubricants have been successful across a range of applications. Product developers have worked with several end-users to establish testing protocol and field trials to help assess product performance. Whether in field tests or in full use, bio-based lubricants have demonstrated performance advantages over petroleum-based lubricants. As product developers continue to refine their product formulations, the benefits listed below should be expected to remain valid and become more significant.

- *Technical performance*
    - Superior lubricity = lower operating temperatures and reduced equipment wear
    - High Viscosity Index = consistent thickness and longer life
    - Meets or exceeds equipment manufacturer's specifications and American Society for Testing Materials (ASTM) standards
- *Environmental advantages*
    - Rapid biodegradability
    - Low aquatic toxicity
    - Potential regulatory benefits
- *Worker safety*
    - Low toxicity
    - High flash point
    - Low volatile organic compound (VOC) emissions
- *Rural economic development*
    - Locally grown crops (Cannola = potential for value-added manufacturing)
    - Renewable = long-term sustainability

These benefits represent the "tripple bottom line" of sustainable development.
Product technology is still under development in the U.S. Much of the technology is based on European applications, which were developed using canola (or rapeseed) oil. Companies here have been modifying the technologies to suit soybean and sunflower feedstock, and some efforts

have been made to increase canola production by farmers. Modifications have been oriented toward ensuring product performance for cold weather uses and improving product stability at extreme heat.

The product purchase cost varies by application. In general, bio-based lubricants cost more than petroleum lubricants and less than synthetic lubricants. In terms of total product cost, including product purchase and use, bio-based lubricants can be competitive with petroleum lubricants. Furthermore, costs to purchase industrial lubricants are small in the context of overall operations, which means any added costs associated with purchasing bio-based products would have limited impact on operating budgets. Experience with bio-based products so far suggests that end users will assess whether to convert to bio-based lubricants based on direct, hands-on use. Continued efforts to foster product trial uses will remain a priority in the short term.

Success Stories

In 1993, the Virginia Department of Forestry conducted an 18-month pilot project to test bio-based hydraulic fluid in fire protection tractors and bio-based bar oil in chain saws. They successfully used vegetable-based oils made by three different manufacturers. In 1995, they committed to using bio-based lubricants in chainsaws and the entire tractor fleet.

In 1995, Yellowstone National Park initiated a project with several state and federal governments and the International Snowmobile Manufacturers Association (ISMA) to evaluate the use and emissions of bio-based fuels and lubricants in snowmobile engines. The program's results led to them to use bio-based two-stroke engine oil and to expand their use of bio-based lubricants to other areas. They have used bio-based hydraulic fluids in their winter trail grooming equipment for the past four years and began using chainsaw oil about a year ago. They planned to introduce the use of bio-based hydraulic fluid in the Park’s garbage trucks during 2001.

The Troy Country Club in New York tested bio-based hydraulic fluid in turf mowing equipment valued at $40,000. During the testing period, the hydraulic systems leaked due to loose fittings. The bio-based fluids caused some bleaching of the grass, but it was fully restored within three weeks, whereas such spills with petroleum lubricants mean replacing dead grass. This incident alone convinced the course superintendent to convert all of their mowers to bio-based hydraulic fluids. In this case, the costs of the lubricants is not significant given the benefits in terms of preventing losses due to fluid spills on turf.

Field test results for one company’s chainsaw bar and chain oil showed clear performance benefits for the bio-based product, both for lubricity and equipment wear. These performance benefits, in terms of less chain sharpening and longer chain life, more than compensated for the higher product costs for the bio-based lubricants. Cost results are illustrated below.

Field Test Information	Petroleum-based oil	Bio-based brand
Product purchase price	$84.00 ($3.50/gal)	$360.00 ($15.00/gal)
Chains	$144.00 (8 chains)	$36.00 (2 chains)
Sharpening	$128.00 (32 @ $4/sharpening)	$32.00 (8 @ $4/sharpening)
Total	$456.00	$428.00

Source: Badger Oil Company, 2000.

Examples of Best Potential Lane County Short Run End-Users

- Port of Siuslaw, Port of Portland, and other ports
- Lane County Parks, Eugene Parks, Willamalane Parks, Oregon State Parks, and other park systems
- Oregon Department of Forestry (chain saw lubricant) and other chain saw users
- Lane Transit District, Tri Met in Portland Metro area, and other local public transportation systems
- Golf courses

Case Study: Saint Peter, Minnesota

Introduction

The past four years have brought unprecedented change to Saint Peter, a community of about 10,000 people in southern Minnesota. In early 1998 a tornado swept through town, causing millions of dollars of damage and beginning a period of intensive redevelopment. In addition to repairing housing, commercial buildings and community assets, the City is now looking at how to turn its old municipal airport – a grass-strip runway on the north side of town – into a state-of-the-art business center. The site is the focal point for creating a high-performance Eco-Industrial Park, in which businesses seek the best possible economic results through superior energy and environmental strategies.

Community Objectives For Economic Development

- Expand and diversify local tax base
- Quality jobs
- Local wealth creation
- Efficient use of community land and resources

Step one in project development was to undertake an in-depth planning phase. This planning approach represents an innovative way to plan for new development, and was fostered through a partnership of public and private organizations interested in sustainable community development for Saint Peter.

- Saint Peter Community Development Corporation
- Saint Peter Ambassadors
- Saint Peter Chamber of Commerce
- NRG, Inc., a private energy provider
- Minnesota Office of Environmental Assistance

These partners provided funding for the initial feasibility study and planning work, including a grant from the Minnesota Office of Environmental Assistance. The City also brought these partners together with local leaders in the community on a project advisory committee, which worked with the City throughout the project.

The planning work included research on resource flows, conceptual design of development projects and market analysis. A critical element of this development approach is to recognize and harness the particular strengths of the community. The economy around Saint Peter is dominated by agricultural activity, and the largest employers within the City are a private liberal arts college and a state-run mental health facility. Existing industries include the corporate headquarters for

an aluminum boat manufacturer, a small manufacturer of specialized, heavy-duty tree trimming equipment, a newspaper publishing operation, a print shop, and even a small company that makes fishing lures. By investing in this relatively more intensive planning work, the City hoped to attain a number benefits, including business 'fit' in the community, maximum efficiency in resource and infrastructure use, targeting for business recruitment, and development strategies for the City to use in pursuing subsequent development.

In Phase I, the City looked at the resource flows into and around the community, among industries, agricultural operations, and institutions like schools and health facilities. This work has pointed to some development concepts that would capitalize on the agricultural resource base in the surrounding area and on local demand that could be served by new business development. The concepts fall within two categories:

- Bio-based chemical production; and
- Community food system

This project summary describes those concepts and discusses ways in which the community can work to pursue development projects in partnership with private enterprises. Ultimately, these efforts can coalesce in the formation of the industrial park.

Bio-based Chemical Production

Farmers understand the need to process the crops they produce in order to realize the full economic value of the fruits of their labor. For years, they have pursued different processing options.

- Soybeans, as well as other 'oilseeds', can be used for a variety of food and health products, animal feed and a range of chemical applications.
- Alfalfa and many native plants can be used for feed, nutraceuticals or biomass fuel.
- Corn can be used to produce ethanol, animal feed and other chemicals.

These opportunities are becoming more promising, giving farmers and small communities a chance to transform their economic conditions through diversification and extensive value-added processing. Part of this development opportunity is based on looking at multiple production streams that complement each other.

Soybeans produced in Minnesota are used to make a variety of processed foods and printing inks. But a number of companies are looking to use the oil from soybeans (as well as canola and sunflowers) for a number of other uses. Governments, agricultural research institutions and business enterprises are exploring a multitude of options for diversifying production options and enhancing commodity value.

- Industrial lubricants – chain saw and bike chain lubricants, two-stroke engine oil, hydraulic fluids.
- Biodiesel – blended in various proportions with petroleum diesel.
- Solvents – industrial cleansing and carriers/diluters.
- Nutraceuticals – nutrition and health supplements, vitamins, medicinal drugs.

Industrial lubricants may be one of the most promising categories. These bio-based products have been successful across a range of applications. Major end-users of bio-based lubricants include national, state and local parks, golf courses, and watercraft engines. Whether in field tests or in full use, bio-based lubricants have demonstrated performance advantages over their petroleum-based counterparts.

Biodiesel is making in-roads into the diesel fuel market, and is expected to become a more significant fuel option in future years. This drive toward biodiesel reflects a desire to begin to address emissions issues associated with diesel-powered vehicles (especially in urban areas) and to expand value-added markets for agricultural products. Research on biodiesel use has consistently shown performance advantages for increased fuel efficiency, reduced engine wear and sulfur-related emissions reductions.

Nutraceuticals represent another emerging market option. Nutrition or health supplements, medicinal drugs, and other products can be produced from soybeans and a wide array of other seeds, as well as many native plant species. The natural properties of seed oils and native plants, complex proteins and high antioxidant levels, are ideal for such product applications. Researchers are continuing to explore the best ways to bring these bio-based products into the marketplace. These product opportunities may be in their initial stages, in terms of product research and development, but they represent high value-added niches and real opportunities for new firms to enter into the marketplace.

Minnesota has been a national leader in ethanol production for many years. However, recent market changes are driving a substantial expansion phase in order to serve urban markets on both coasts. In addition to producing ethanol, these facilities can capture the full economic value of the corn. A number of facilities use the residual from the ethanol-making process as a high-protein animal feed. More opportunities exist for productively using the residual material, such as using the plant waste to produce synthetic gas for commercial use.

Benefits to Saint Peter

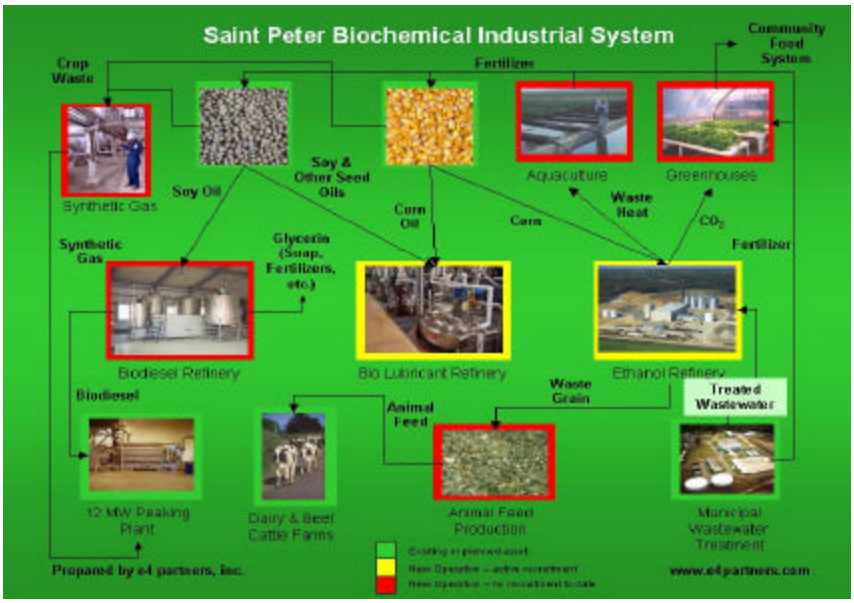
Pursuit of these development opportunities and community sustainability initiatives can help Saint Peter achieve its objectives for development. These opportunities are oriented toward new business development, can be developed in phases and started with modest capital investments, and help to reinforce connections between production and consumption within a community.

The detailed development opportunities described in this report offer the City a great advantage for business recruitment, by offering a conceptual vision for the type of business development it is seeking. In contrast, most communities of similar size and demographic characteristics take a less directed approach to economic development, and often respond to businesses that are evaluating a number of communities. In fact, this dynamic is currently present in Saint Peter, as outside companies inquire about available facilities in the City and evaluate the prices offered by ‘competing’ cities. By having this conceptual vision, Saint Peter may be able to give local entrepreneurs and business leaders a chance to pursue these opportunities in partnership with the City. In addition, outside businesses can come to the City with a greater understanding of the City’s goals for economic development. Potentially, with an aggressive outreach effort, the City may find several outside businesses competing to be part of its new development.

The sustainability initiatives will further enhance the City's ability to reap those rewards, by creating an environment that rewards development consistent with the opportunities identified in this planning process. The sustainability initiatives should offer the community further benefits related to:

- Greater flexibility for energy use in the community, and opportunities for further incentives for conservation and energy cascading;
- Increased land productivity, in terms of higher and better use, greater land use densities in developed areas, conservation of undeveloped land, and lower costs to provide infrastructure to developed or developable land;
- Reduced infrastructure and utility costs for new building construction, lower building operating costs, and improved building performance for the people working in them; and
- Better tools for identifying factors that directly affect community sustainability, along with a set of measures for monitoring progress, relating progress to community residents and businesses, and changing programs and policies to support sustainable activities.

The following charts outlines how a bio-refinery has been pursued in St. Peters, MN.



Bio-Refinery Development Process, Saint Peter, Minnesota

Project Organization and Initial Planning

- Present Eco-Industrial Development Concepts to Community Leaders
- Develop EID Advisory Board
- Identify Local EID Champion/s

Baseline Investigation

- Inventory Community Assets
- Analyze Local Private & Public Sector Flows of Raw Materials, Goods & Services
- Analyze Regional Flows of Raw Materials & Finished Goods
- Identify Underutilized Facilities, Equipment

Analyses and Planning

- Identify and Conceptualize EID Systems and Strategies
- Identify Actual and/or Prospective Anchor and Ancillary Enterprises
- Conduct Feasibility Studies for Local Development of Anchor and Ancillary Enterprises

Business Development Activities

Anchor Enterprises

- Identify Champion/s for Anchor Enterprise Development
- Identify Existing Anchor Enterprises and/or Entrepreneurs
- Existing Lubricants, Ethanol, & Biodiesel Enterprises
- Farmer Cooperatives (unaffiliated with above)
- Independent Entrepreneurs
- Begin Recruitment Dialogue with Interested Parties
- EID Advantages
- City Incentives and Controls
- External Incentives Available
- Integrate External Parties into Recruitment Dialogue
- State Agencies (Commerce, Trade & ED, Agriculture)
- Federal Agencies (Agriculture, Energy)
- Local Commercial Banks and/or Equity Investors
- Select Anchor Enterprise/s and Commence Development Program
- Review Workforce Requirements for Anchor Enterprises

Ancillary Enterprises

- Identify Existing Ancilliary Enterprises and/or Entrepreneurs
- Qualify Anchor Tenant/s Interest in Ancilliary Enterprise Development
- Existing Synthetic Gas, Animal Feed, Glycerine, Aquaculture, Greenhouse Enterprises
- Farmer Cooperatives (unaffiliated with Anchor/s)
- Independent Entrepreneurs
- Same Recruitment Process As Above

Policy, Regulatory, Infrastructure Activities

Local Incentives

- Identify Local Incentives for Eco-Industrial Development Program
  - Property Tax Incentives
  - Water, Wastewater, Electricity, Gas Efficiency Incentives
  - Permitting Streamlining

Local Controls

- Identify Local Controls for Eco-Industrial Development Program
  - Changes to Building, Zoning Codes
  - Codes, Covenants & Restrictions Attached to Properties
  - Changes to Comprehensive Plan
  - Explore Potential for Innovation in Applicable State and County Regulations
  - Mandate Sustainable Design Guidelines for new development exceeding cost threshold

Infrastructure

- Identify Necessary Infrastructure Investments
  - Site Specific (Utilities, Access)
  - Community Wide (Water, Wastewater, Electricity, Access)

Near-Term Steps To Development of a Bio-Refinery in Lane County

Based on the St.Peter's example, the following short-term actions can build toward the development of a bio-refinery and bio-based lubricant industrial system in Lane County.

- Focus on packaging, marketing and distribution of selected products. Specific product market analysis is needed and a business enterprise needs to be created to undertake the necessary business planning. Careful attention to satisfying questions of potential end users will be needed at the beginning.
- Analyze adding crushing and blending capacity needs, and identify an initial scale of production that strikes a balance between end user demand and ability to secure feedstock.
    - A mini-mill is the most likely path for developing crushing capacity. A mini-mill can be designed to process quantities ranging from 10 tons per day to 500 tons per day. If a mini-mill were considered, the scale should tend toward the high end of the capacity range. Capital cost estimates for such a facility range from $5 to $10 million (*Opportunities for Value-added Utilization of Oilseeds and Oilseed Products in Minnesota*, AURI, 2000).
    - A facility for blending and refining into desired products should be developed in tandem with the crushing operation. Costs to equip this facility could run from $200,000 to $400,000, depending on size. This estimate reflects availability of an existing 10,000-ft^2 building in good condition in proximity to a crushing facility.

Potential Immediate Steps

- Form an exploratory committee composed of interested entrepreneur, individuals, businesses, farmers, academic, and government leaders interested in the business concept. The first priority should be to become educated about the potential of developing a bio-refinery.

- The committee can work with interested entrepreneur/s could take following steps toward business creation:
    - Refine market data and analysis related to specific products to be considered.
    - Pursue product testing and purchase commitments from regional customers to establish initial revenue stream.
    - Enter into negotiations with product developer on technology licenses for selected products.
    - Explore regional blending capabilities and identify preferred vegetable oil suppliers.
    - Finalize business plan.
    - Raise needed start-up capital.

- Finally, local governments and economic development agencies can be engaged in analysis of policy changes and programs required for success.

C. RENEWABLE ENERGY

1. Biomass Energy

Wood-burning stoves and fireplaces are the most primitive form of biomass energy production. Biomass energy uses the embodied energy in organic materials like "energy crops" or agricultural and forestry waste to produce energy in the form of electricity or heat. Several different processes generate energy from biomass on a larger scale:

- *Direct-fired consumption* processes directly burn biomass residues or "energy crops" for energy. This process can either provide electricity, if the steam from combustion drives a turbine, or provide heat, if the energy is immediately used for consumption. Combined heat and power (CHP) processes produce both electrical and heat energy.

- *Cogeneration, or co-firing,* is similar to direct-fired consumption, except that the biomass is burned with traditional fuels, like coal or natural gas.

- *Anaerobic digestion.* Landfills contain constantly decomposing organic materials that produce large quantities of methane. Animal waste from agricultural facilities also produces methane gas. Anaerobic digestion harnesses the energy of methane gas by collecting and burning it for electricity.

- *Gasification* is a relatively new technological development. The process converts solid biomass to gas form. The gas is cleaned and filtered, then used in efficient gas- and steam-turbine electricity generation processes.

All four methods are being used in the United States and worldwide. The U.S. currently holds 7,000 MW of installed biomass capacity, concentrated in the industrial sector[14].

Biomass energy carries economic and environmental benefits, although economic and environmental concerns also exist. There is a huge economic potential for biomass: the U.S. Department of Energy estimates that by 2020, 30,000 MW of biomass-powered energy will provide over 260,000 new jobs nationwide[15]. However, pure biomass plants have higher capital and operations costs than traditional fossil fuel plants, with reduced output efficiencies[16]. Co-firing biomass with fossil fuels in existing facilities is the most economical option, yielding energy costs of 0-4 cents per kWh in facilities where fuel stock consists of 10-15% biomass[17]. Landfill and agricultural gas generation can also be economical – energy costs range from 3.5-7.9 cents per kWh[18]. In Oregon, residential electricity costs 5.1 cents per kWh and industrial electricity costs about 3.6 cents per kWh, making biomass a cost-competitive option.[19]

The environmental benefits of biomass energy are also uncertain. Ideally, biomass energy diverts waste from landfills, provides an opportunity for more efficient (and less polluting) combined heat and power processes, and utilizes renewable resources. Although biomass energy diverts waste from landfills, critics worry that reliance on biomass energy from waste will hinder zero waste initiatives (see Section D for more information on Zero Waste), by decreasing the incentive to recycle and reuse. From a climate change perspective, biomass energy can be sustainable only if organic inputs are raised and harvested sustainably, and the biomass process replaces traditional fossil fuel generation[20]. However, biomass inputs must be replanted so that

they can absorb enough carbon dioxide to balance out carbon dioxide released during energy generation. Air quality in the southern Willamette Valley may also be a concern, especially during periods of temperature inversions. Generally, biomass generation produces less of other air pollutants, like sulfur and nitrogen oxides, than traditional energy production[21] . Despite some drawbacks, biomass energy can be a viable, sustainable option if used with care and foresight.

Biomass Opportunities in Lane County

As stated earlier, most biomass generation facilities are built as a part of existing industrial facilities or generation stations. In these cases, the biomass industry in Lane County only requires the opportunity to add to existing processes and the biomass inputs; special equipment and new businesses are unnecessary. Stand-alone and gasification systems require special equipment, as well as hefty start-up funding. These systems also require a need for additional energy supply, which is absent in Lane County. An opportunity exists in the southern Willamette Valley for existing organizations to maximize profits by reducing their own energy costs through the use of biomass based energy (in the case of agricultural waste or industrial applications) or producing excess electricity for resale (in the case of landfill gas applications).

However, most of Lane County's electricity comes from comparatively inexpensive hydropower, which makes biomass cogeneration difficult to justify for many organizations. As stated earlier, stand-alone and gasification biomass generation facilities are still fairly expensive, and not necessarily environmentally sustainable. Lane County already has a successful landfill methane generation facility at Short Mountain landfill, near Eugene. The project cost $2.6 million to construct in 1993 and has been producing an average of 20 million kWh per year[22]. Lane County could expand its biomass production capabilities by focusing on agricultural anaerobic digestion and industrial processes:

- *Agricultural Methane*: The waste from the county's 28,000 cattle and calves[23] could produce 10.8 MWh/yr[24] if its methane was harnessed for electricity production. Lane County could join with local economic development and agricultural agencies, private firms, and others to hold a series of workshops to educate local farmers about electricity production from methane and to encourage them to apply for the state's business energy tax credit (see below).

- *Industrial Co-Generation*: Lane County could explore combined heat and power opportunities with industrial facilities for biomass cogeneration. Possible fuels include wood waste from wildfire-thinning projects, or lumber processing. Care should be taken to ensure that fuels are harvested sustainably to close the carbon dioxide cycle.

To fund these projects, Lane County could take advantage of the State of Oregon's renewable energy funding mechanisms. The loan program offers funding for Oregon public agencies, businesses, and residents to implement cogeneration or landfill gas recovery projects. Loan rates and terms vary by sector. The state also offers a business energy tax credit for 35% of eligible project costs. Biomass projects are eligible if the applicant can show that the biomass resource is available in excess of the project input needs. The county could encourage businesses and residents to implement biomass projects that utilize waste products and/or provide cogeneration

opportunities. By using state funds to finance a handful of local projects, the County could create models for future projects, and begin the process of local market transformation.

Municipal Biomass Case Studies:

McNeil Generating Station in Burlington, VT

In the 1970s, Burlington, VT obtained most of its electricity from a 1950s coal-fired system. Burlington Electric began to look for a better way to meet the areas growing electricity needs. After comprehensive studies, Burlington Electric decided that a wood-fueled plant would be a less polluting way to meet the community's generation needs. Also, a wood-fueled plant would be economical, keep money in the local economy and provide jobs to residents. In 1977, Burlington Electric modified the existing coal-fired systems to allow wood chip co-firing. After this successful pilot, the City of Burlington passed a bond issue to pay for construction of a new generating station. The McNeil Generating Station was built in 1984 to burn either natural gas or wood for power grid electricity. The project was completed $13 million below the original $80 million budget estimate.

McNeil Generating Station uses untreated wood fuel, including 85% forest residue, 10-15% mill waste and a small amount of pallet and yard waste. They have developed a sustainable harvest program and make a concerted effort to maintain the environmental viability of the system.

Recently, Burlington Electric installed a demonstration gasifier for research and development. Now, Burlington Electric is looking into using the waste steam from the station to generate heat for local buildings. For more information: Burlington Electric Department, 585 Pine St, Burlington, VT 05401; 802-658-0300; www.burlingtonelectric.com

California Dairy Power Production Program: "Money for Methane"

The California Energy Commission (CEC) funds the California Dairy Power Production Program as part of the state's demand reserves partnership. The program provides ag interests with financial incentives to develop manure methane power generation on dairy farms, using either plug flow reactors or lagoons. Assistance includes:

- Buy down grants covering a portion (less than 50%) of system capital costs
- Incentive payments for generated electricity (5.7 cents/kWh over initial 5 years)

The program uses an advisory board that includes state and national agencies. The CEC appropriated $9.6 million for this cost-sharing project, with a goal of achieving 5 MW of dairy bio-gas infrastructure by the summer of 2002. Unfortunately, the group did not achieve this goal. As of May 2003, the program had received 46 applications and approved 10 of those for funding. The progress was slow for several reasons:

- Capital costs were much higher than initially estimated
- Permit and interconnection agreement processes were delayed
- Low milk prices made it difficult for farms to commit to additional expenditures

The program readjusted its goals and extended its installation date to December 31, 2003. The economic benefits for participating farms is great – the program estimates that electricity for the 10 initial projects will total about $863,669. For more information: Western United Resource Development, Inc (Administering Org), 1315 K St, Modesto, CA 95354; 209-527-6453; www.wurdco.com

*2. Biofuels**

Biofuels derive their energy from organic sources, typically agricultural "energy crops" (soybeans and oilseed crops), agricultural waste (including corn husks) or waste grease from food service. After processing, these organic inputs become fuel for uses such as transportation. Fuels can take the form of biodiesel or ethanol. Retrofitted diesel vehicles can use pure biodiesel fuel, or biodiesel can be added to traditional diesel fuel in small quantities. Ethanol can either be used as an oxygenate to help traditional gasoline burn more cleanly, or as pure fuel for retrofitted vehicles.

Biofuels create environmental benefits of reduced vehicle emissions and reduced agricultural and restaurant waste. The U.S. Environmental Protection Agency believes biodiesel can reduce particulate matter emissions by 47%, unburned hydrocarbons by 67% and carbon monoxide by 48%[25]. From an economic perspective, the biofuels industry creates job at all three levels – manufacture, distribution and vehicle retrofit. Biofuels also offer an opportunity to bolster the agricultural industry by providing "cash crops" as inputs. Energy crops require sustainable harvesting in order to ensure overall the overall process sustainability. In Oregon, the agricultural sector is one of the economy's largest industries and has been hurt by the state's flailing economy. Biofuels appeal to consumers because the cost/gallon can be competitive with proper scale, and minimal vehicle retrofits are required.

The biofuel industry requires different technology and infrastructure for biodiesel and ethanol production, distribution and application. Biodiesel fuel can be produced on either a small or large scale and requires large quantities of organic input. The world's largest producer of biodiesel fuel from used restaurant oil is Las Vegas-based Biodiesel Industries (BI). The corporation's current capacity is 3 million gallons per year and it relies on other corporations, like Nevada's Haycock Petroleum, to distribute its product.[26]

Ethanol can also be produced on different scales. On farms, waste can be collected and fermented to produce ethanol. More traditionally, ethanol is produced in large-scale industrial facilities, often as a byproduct from other processes.

Biofuels Opportunities for Lane County

In order to provide an example and jump-start the local biofuels market, Lane County government could consider a biodiesel initiative for county-owned vehicles. A consortium could be developed with Lane Transit District buses, public school buses, and local government fleets throughout the county. In Las Vegas, NV, the Nevada Energy Office opened up the nation's first biodiesel fueling station in 2001. The city now uses 200,000 gallons of biodiesel annually for its fleet.[27]

SeQuential BioFuels, a Eugene company, has teamed up with Tyree Oil, Inc to provide marketing and distribution of biodiesel. The company charges customers between $1.99 and $2.09 per gallon of 20% biodiesel (80% diesel), and between $2.38 and $2.58 per gallon of 100% biodiesel[28]. "Cardlock" members have access to SeQuential's 24-hour fueling station. SeQuential and Tyree buy the fuel from World Energy Alternatives, a national biodiesel production company. A large business opportunity exists for local biodiesel production, since the infrastructure exists for distribution and use. Also, as biofuel use increases in Lane County, additional organic inputs will be needed to meet the demand. This provides a tremendous opportunity for local farms. As needed, biofuels manufacturers can secure contracts with local farmers to obtain "biofuels crops" for production input. The climate in Lane County does not allow for soybean crops, and rapeseed is not allowed to flower in the region, due to dangers of cross-pollination. However, rapeseed production just east of Lane County could provide the organic materials necessary to feed the County's biofuels market. As the market grows, distribution opportunities for businesses beyond SeQuential Fuels may arise, as well.

The need for local biofuels production need not be met by agricultural inputs. Community-led groups that create biodiesel from used restaurant oil are springing up all over the country (see

Berkeley Biodiesel Co-op Case Study below). Either a corporate or community-led approach could facilitate small-scale biodiesel production, with limited technical equipment necessary.

Initial funding for biofuels efforts can be obtained from state and federal resources. The State of Oregon provides a 35% tax credit for the cost of installing alternative fuel storage tank or dispensing facility through its Business Energy Tax Credit Program[29]. The state also offers incentives to truck owners who retrofit their engines to accept biodiesel[30]. The federal government also offers incentives and tax breaks for individual alternative energy vehicles, refueling centers and corporate alcohol fuel use.

The local demand and infrastructure for biofuels in Lane County is growing, and local businesses and residents have a tremendous opportunity to tap into this industry and promote local sustainability.

One opportunity in Lane County may be for a consortium of local governments and public agencies to purchase 100% bio-diesel and mix it with regular diesel at levels that make the mixture cost effective yet reduces toxic emissions (e.g. 90-10 or 85-15).

Community Biofuels Case Studies

Berkeley Biodiesel Co-op

In 2000, several members of the Berkeley Worms Composting Collective became interested in creating a cooperative group to produce biodiesel in the East Bay area. In September 2002, the group was officially founded under the Ecology Center, a Berkeley community sustainability center. It began as a production cooperative, but membership demand soon exceeded production. The Berkeley Biodiesel Co-op addressed its members growing fuel needs by forming a bulk buyers club. The group now has three aims:

- Biodiesel advocacy
- Small-scale biodiesel fuel production from Berkeley restaurant grease waste
- Bulk biodiesel fuel buyers club

Group members pay quarterly dues of $25 dollars. About 30 people are members of the co-op and a dozen or so of them are very active. At monthly meetings, the group uses consensus to make decisions. The co-op currently produces about 100 gallons of biodiesel fuel per month and bulk purchases another 1,000 gallons from Yakayo Biofuels, a biodiesel distributor.

For more information: Berkeley Biodiesel Co-op, www.biodiesel.org
(Information from interview with Daniel Sherwood, current active co-op member

Washington State Biofuels Legislation

In May 2003, the Washington State legislature passed a package of tax breaks aimed at jump-starting the biofuels industry. The package provides tax incentives for companies in the biofuels industry, suggests that state and local agencies purchase biofuels, and initiates a biofuels pilot project for school buses. Washington wants to attract biodiesel manufacturers to the state and also reduce air pollution.

For more information:
House Bills 1240, 1241, 1242, 1243: http://www.leg.wa.gov/pub/billinfo/2003-04

3. *Hydrogen*

Background on Hydrogen and Hydrogen Fuel Cells

Hydrogen has the highest energy content per unit weight of any known fuel. When hydrogen burns with oxygen, it produces heat and water without toxic emissions. Fuel cells are a devise that converts fuel into electricity. The device also permits the storage and distribution of energy in the form of fuel.

Hydrogen can be produced from renewable resources, such as reforming ethanol (natural gas) and by splitting water (electrolysis). However, there are other ways of producing hydrogen power: by the gasification of fossil fuel and by converting biomass into electricity. Electrolysis emits nothing but water as a byproduct, but it is relatively expensive. Reforming ethanol emits some carbon dioxide, but costs the least. As a result, reforming ethanol is the most widely used, shown in Table 3 (a) below.

Table 3 (a)

	Amount in Billions	
Origin	**Nm3/ year**	**Percent**
Natural Gas	240	48
Oil	150	30
Coal	90	18
Electrolysis	20	4
Total	500	100

Source: National Hydrogen Association

Fuel cells use an electric current to separate water into its components-- hydrogen and oxygen. The electricity enters the water at the cathode, a negatively charged electrode, then passes through the water and exists via the anode, the positively charged electrode. The hydrogen collects at the cathode and the oxygen collects at the anode. Electrolysis does not require a significant amount of water. The hydrogen extracted from a gallon of water using a hydrogen generator could drive a hydrogen fuel cell vehicle as far as an average gasoline vehicle travels today on a gallon of gasoline.

Why Promote Hydrogen?

1. *Economic Incentives*
   Converting to a hydrogen-based economy would create thousands of permanent scientific and industrial jobs. Building plants, manufacturing parts, selling equipment, and developing technology could be important investments that would stimulate U.S. jobs and economic growth. Hydrogen production technology has continually expanded across the globe in the past decade. Investing in hydrogen development would keep the U.S. in step with global competition for energy resources.

2. *Energy Efficiency*
   Hydrogen power is very energy efficient. The amount of energy produced by hydrogen per unit weight of fuel is about three times the amount of energy contained in an equal amount of gasoline and almost seven times that of coal.

3. *Energy Security and Self-Sufficiency*
   Research shows that fossil fuel production will peak within the next 10-15 years. Once the peak is hit, prices are likely to skyrocket while hoarding and other economic problems are likely to prevail. Hydrogen is renewable and virtually unlimited. Hydrogen energy can be made from the electrolytic decomposition of water, and becomes water again when joined with oxygen in a fuel cell. Solving our energy supply and security problems through hydrogen can help ensure economic stability.

4. *Environment and Public Health*
   Hydrogen is clean and efficient because the mechanism of fuel cells utilizes chemical reaction rather than combustion. Hydrogen emits no toxins; therefore, air quality can be improved by shifting energy source from fossil fuels to hydrogen. Hydrogen spills would evaporate immediately, while oil spills severely damages water conditions and food chains. Many researchers have raised questions about the potential environmental effects of using natural gas (fossil fuels) to produce hydrogen. Others have raised concerns about the effects on the ozone layer of the release of substantial amounts of hydrogen production into the stratosphere. The former issue can be resolved by moving to electrolysis as quickly as possible. Many hydrogen researchers believe the later can be addressed through technologies that prevent hydrogen releases.

Applications for Fuel Cells

There are many uses for fuel cells. Fuel cells can power hospitals, police stations, buses, trains, vending machines, vacuum cleaners, laptop computers and highway road signs. Listed below are different types of applications fuel cells can take to install powering systems:

1. *Stationary*
   Stationary fuel cells refer to large-scale, on-site power generation systems, such as those in airport terminal, hospitals, schools, and any other public buildings. In large-scale building systems, fuel cells can reduce facility energy costs by 20-40% over conventional energy service[31].

2. *Residential*
   Fuel cells are ideal for power generation, either connected to the electric grid to provide supplemental power, or installed as a grid-independent generator for on-site service in residential areas. Since fuel cells operate silently, they reduce noise pollution as well as air pollution. Moreover, the waste heat from a fuel cell can be used to provide hot water or space heating for home.

3. *Transportation*

Currently, all the major automotive manufactures have a fuel cell vehicle either in development or in testing stages. Manufactures speculate that the fuel cell vehicle will be commercialized as early as 2004.

4. *Portable/ Mobile*
   Applications for micro fuel cells include pagers, video recorders, cell phones, smoke detectors, and so on. These miniature fuel cells generally run on methanol, an inexpensive wood alcohol also used in windshield wiper fluid.

5. *Landfill/ Wastewater Treatment*
   Fuel cells currently operate at landfills and wastewater treatment plants. This system not only generates power, but also reduces emissions from the waste.

An Overview of the Existing Hydrogen Industry

The U.S. hydrogen industry currently produces nine million tons of hydrogen per year, which equals enough power to operate 20-30 million cars or five to eight million houses. Manufacturing sectors, such as chemicals production, petroleum refining, and metal treatment, utilize hydrogen power the most.

Hydrogen is usually transported by pipeline or by road. The hydrogen pipelines, which are owned by merchant hydrogen producers, are limited to a few areas in the U.S. where large hydrogen refiners and chemical plants are concentrated in certain areas, such as Indiana, California, Texas, and Louisiana. Hydrogen can be stored as a compressed gas or liquid, or in a chemical compound.

Most of the hydrogen produced today is consumed on site, such as at an oil refinery, and is not sold on the market. For large-scale production, hydrogen costs $0.32/lb if it is consumed on site. When hydrogen is sold on the market, the cost of liquefying the hydrogen and transportation must be added to the production cost. This can increase the selling price to $1.00-$1.40/lb for delivered liquid hydrogen. The cost of water-split hydrogen, which is relatively pure, is typically $1.00-$2.00/lb.

Business Opportunities and Existing Oregon Companies

There are many manufacturing opportunities to be developed in the all stages of hydrogen power, such as the generation, processing, storage, and retail of hydrogen power. The fuel-cell-related products include fuel stack and its component, fuel cell systems, hydrogen equipment, and testing devices.

Table 3(b) shows some of the component parts of fuel cell manufacturing (and hence business opportunities) and their market prices as of July 2003. The prices were collected from several different retail establishments in the U.S. As shown in the table, majority of the products are value-added and belonging to high price manufacturing. Also, some of the products need to be custom-built, which means that the industry would create high-wage technical jobs in addition to manufacturing jobs.

Table 3(b). Sample Products/Business Opportunities and Their Market Price

Product Name		Price Range
Fuel Stacks	0W<2W	$30-$600
	3W<10W	$300-$1,000
	11W<19W	$1,000-$1,500
	20W<100W	$1,500-$9,000
	150W<800W	$3,500-
	kW	$6,000-
	Direct Methanol	$100-$2,000
Fuel Cell Systems	Demonstration	$200-$6,000
	Sub kW	$3,000-
	kW	$6,000-
	Residential	Custom
	Commercial	Custom
Hydrogen Equipment	Connectivity	$50-100
	Gas Detection	$100-200
	Gas Handling Systems	Custom
	Gas Humidifier Systems	Custom
	Gas Purification	$2000-
	Hydrogen Compressors	$7,000-
	Hydrogen Drier	$20-$200
	Hydrogen Production	$1000-$15,000
	Hydrogen Storage	$100-$2,000
Stack Components	Electrode Backing (Carbon Fiber Paper)	$7-$10
	End Plates	$30-$90
	Graphite Plates	$500-$1,500
	Membrane Electrode Assemblies	$40-$150
	Membranes/ Solutions	$30-$180
	Mylar Surrounds	$1-$2
Testing	Direct Methanol Fuel Cell	$9,000-
	Fuel Cell	$1,000-
	MEA/ Membrane	$1,000-

A small number of Oregon companies are already involved in the hydrogen industry including four hydrogen generators (and/or distributors) and three fuel-cell-related equipment producers or retailers identified in Table 3(c).

Table 3(c). Oregon's Fuel Cell Companies

Generator/ Distributor	Place
Central Electric Co-operative	Redmond
Columbia Blvd. Wastewater Treatment Plant	Portland
Emerald Peoples Utility Distribution	Eugene
Portland General Electric Earth Advantage National Center	Portland

Fuel Cell Related Manufaturing/ Retail	
Bonneville Power Administration	Portland
Ida Tech	Bend
Portland General Electric	Portland

Issues to Address

1. *Storage*
   Hydrogen is 14 times lighter than air and poses difficult storage problems. Recent techniques to store hydrogen include metal hydride tanks, compressed hydrogen, liquid hydrogen, chemically stored hydrogen, carbon nanotubes, glass microspheres, and liquid carrier storage tanks. The overall criteria for choosing a storage method should be safety and ease of use.

2. *Overcoming public fear*
   Hydrogen has suffered from image problems in the past: mostly from the Hindenburg disaster and the development of the hydrogen bomb. In fact, hydrogen is an energy carrier and possesses similar characteristics inherent to any of the fossil fuels commonly used today. When education and correct handling methods are applied, hydrogen is actually safer than many common fuels already in widespread use.

3. *Converting the pre-existing infrastructure*
   To be successful, hydrogen requires a new energy infrastructure, such as pipelines, fueling stations, automobile engines. This will require major investments and take time.

Some States Have Already Committed to Hydrogen as an Economic Development Priority

1. *Michigan and Ohio*
   The State of Michigan launched a comprehensive economic plan, called the "NextEnergy" project to create an industrial park for fuel cell companies. The State aims to become the world's leader in fuel cell research, development, manufacturing, and commercialization. The industrial park is a 700-acre, tax-free research zone, attracting alternative energy companies from around the world. In addition to the tax incentive, the State established the NextEnergy Center to promote the hydrogen economy, collaborating with the State, various federal programs, the University of Michigan, the public utility board, and other private companies. Thus, the companies that agree to become a part of the park will be able to be a part of the NextEnergy research consortium (den).

The State of Ohio unveiled the "Third Frontier Project", which is a ten-year, $1.6-billion proposal to promote high-tech research. The fuel cell portion of that plan comes in the form of a three-year, $100 million plan to make Ohio a national leader in developing the new technology. Ohio's plan heavily relies on the tax and employment incentives.

Also, there is a movement of clustering fuel cell industry region wide. Most political and business leaders of the Midwest states recognize that commodity manufacturing is a declining economic base and that some collective thinking must happen for the region to take advantage of at least some of the opportunities that fuel cells present. That is why there has been some talk of joint efforts for the entire region. They see the Western region, European countries, Japan, and Canada as competitors rather than the state within the same region.

2. *California*
   The State of California is taking the lead in facilitating the broader introduction of stationary fuel cells as one of the preferred technologies for distributed power. In 2001, a group of organization is formed what is known as the California Stationary Fuel Cell Collaborative. The purpose of the Collaborative is to take a leadership role in facilitating the advancement, demonstration, and use of fuel cells for power generation in stationary applications throughout California. It is the intention of the Collaborative to implement an inter-organizational policy to utilize fuel cells in government facilities. This government facility project will be a pilot project to identify and address regulatory barriers, evaluate and distribute data on the potential for commercialization of fuel cells for power generation in California.

Potential for Hydrogen and Fuel Cell Development in Lane County

The national trends of the industry and the explicit decision by Ohio, Michigan, and California to make major investments to grow the fuel cell sector suggest that the potential exist for Lane County to capture a piece of the growing hydrogen fuel cell industry. In our research we found that most hydrogen fuel cell related companies could locate almost anywhere. That is, there are few, if any, structural issues that constrain where they locate. For example, in June 2003, PWCH director Bob Doppelt met with Ken Butcher, Vice President of Porvair Fuel Cell Technology of Hendersonville, North Carolina, and asked why his company was located in Hendersonville and if he saw constraints on where the firm could be located. Butcher's answer was that the firm was located in Hendersonville simply because the parent company at that time had an unused physical plant available. Butcher said that his company could be located anywhere that had decent infrastructure for air and highway travel. Butcher also noted that his highly educated workforce liked the quality-of-life and easy access to the outdoors that Hendersonville offered (the town is located in the Smokey Mountains about 20 miles south of Asheville).

Given the lack of specific locational constraints, Lane County may at least three major advantages that suggest it is feasible to promote hydrogen fuel cell related businesses locally.

1. *Labor Capability*
   The existence of the University of Oregon and a number of research institutes is a great advantage. In most cases, academic institutions and top quality research facilities play a significant role in the research, development and patenting of the components of the

hydrogen industry and infrastructure. In addition, the fuel cell industry requires highly skilled labor, especially Ph. D -level engineers and designers (the industry also hires manufacturing jobs). Lane County has a highly skilled labor pool. These factors could be a source of competitive advantage when promoting Lane County as a center of excellence in hydrogen fuel cell development.

2. *Lane County's Green Reputation and High Quality-of-Life*
   As Ken Butcher of Porvair Fuel Cell Technology said, high quality-of-life factors such as good schools, easy access to the outdoors, a small town environment, and Oregon and Lane County's "green" reputation could prove to be sources of competitive advantage when seeking to attract or retain the highly educated and skilled workforce required of most fuel cell companies.

3. *Ample Water Resources*
   Lane County has plenty of water resource compare to most other places in the U.S. Water-based power generation (electrolysis) could be the most efficient method of producing hydrogen out of all the methods that are known thus far. Lane County has a number of dams that could potentially be retrofitted for hydrogen production. The ample water supply could also be used in other ways for electrolysis. It is widely know that fossil fuels will hit their peak production within next 10-15 years.[32] Economists say that once the peak is reached, prices are sure to skyrocket while hoarding and other potential economic disruptions may occur. The coming of the peak of oil production strongly suggests that the world's energy regimes—and thus economies--will experience major changes in the not too distant future. Currently, electrolysis accounts for only a small part of hydrogen production, although it is 80 to 85 percent energy efficient. The reason is the current cost compared to the use of natural gas. As the price of fossil fuels rises, however, the costs are certain to even out and eventually favor electrolysis. Lane County could seek to create competitive advantage in the industry now by developing its electrolysis potential.

Recommendations For Growing The Local Hydrogen And Fuel Cell Related Industry:

- Establish an exploratory committee composed of representatives of local and state government, academia, and the private sector to explore the potential of promoting research, development, manufacturing, and the commercialization of hydrogen production and fuel cell component parts.
- Investigate the strategies and incentives utilized by other states and communities where hydrogen and fuel cell technologies are located and promoted.
- Develop pilot projects in County and municipal facilities to identify regulatory barriers, economic feasibility, and job-creation potential.
- Obtain industry feedback of the government facility projects to set up strategic plan, which will promote commercialization of fuel cell power
- Investigate potential new technologies applicable to Lane County, especially in the field of water-based hydrogen technology

4. Solar Energy

Solar Energy devices capture the light or heat energy from the sun and produce electricity or facility heating. Solar energy can take several forms:

- *Photovoltaic (PV),* or solar electric panels, convert the sun's light energy into electricity. These solar panels can be placed atop buildings, towers, or other structures and work effectively in most climates. As technology advances, photovoltaics are taking the form of roofing shingles, structure siding, and even windows. The electricity generated from the photovoltaics can either be fed directly to the facility, or to an electric utility. If the electricity is fed to the utility, the utility is required to let the user exchange any extra power produced by their solar system for utility power when the system is not producing enough electricity for the facility's needs. This concept, called net metering, is an Oregon state law. These panels work even when it is slightly cloudy, making it a viable option in Oregon.

- *Solar hot water heaters* use the sun's heat to warm water in coils exposed to the sun's rays. In some climates, solar hot water heaters can be the sole source of water heating, but in most places, such as Lane County, solar hot water heaters are used as pre-heating treatment to reduce the load on traditional water heaters.

- *Passive solar design.* When designing a new building, the building can be oriented to take full advantage of the sun's light and heating rays – this is called passive solar design. A house designed with solar access in mind maximizes natural sunlight infiltration and minimizes glare while maximizing solar heating in the winter and minimizing solar heating in the summer. These design specifications significantly reduce the facility's overall electricity needs.

Each of these methods is used throughout the country. Between 1990 and 1997, 1.8 million solar hot water heaters were sold.[33] From 1993 to 2001, installed photovoltaic capacity shipments increased from 6,137 to 36,310 kW [34]

Each type of solar energy utilization provides both different environmental and economic benefits. Solar hot water heaters are fairly inexpensive to install ($1500-$3500), and will provide savings of $200-$300 annually for a family of four, with an annual payback period of 7-10 years.[35] After the payback period, users will continue to see annual savings for an additional 15 to 40 years.[36] From an ecological standpoint, the carbon dioxide prevented during 20 years of solar hot water heater use totals over 50 tons[37]

Effective passive solar design adds only 2-4% to facility design costs, but reduces annual energy bills between 50 and 90%, which prevents carbon dioxide emissions from traditional energy sources.[38] Daylighting, a component of passive solar design, also has been shown to increase productivity in commercial facilities, and increase student test scores in schools.[39]

The economic case for photovoltaics is not as compelling – the capital costs can be prohibitive. However, once photovoltaics' capital costs are overcome, they require very low operating costs and can yield economic savings. Although purchase costs continue to decrease, a typical PV system costs about $8,000 for each kW of peak power and most homeowners install a few kW of

peak power[40]. Also, in areas where power lines do not already extend, photovoltaics are usually cheaper than extending existing power lines.[41] Photovoltaics create no pollution during power generation – 100 MW of installed solar electric panels will prevent more than 3 million tons of carbon dioxide to enter the atmosphere over their 20-year life.[42]

Solar Energy Opportunities in Lane County:

The solar energy field is a rapidly growing market: between 1988 and 1999, worldwide PV sales increased by a factor of six.[43] Solar energy manufacturer, distribution and installation provide numerous job opportunities at varying skill levels. The National Renewable Energy Laboratory projects that within 50 years, 150,000 Americans will work in the domestic photovoltaic industry and 'by the end of the 2020s, the industry expects to double this employment-with jobs at the same level currently supported by General Motors or the U.S. steel industry."[44] There are significant job opportunities at each level of the industry – manufacture, distribution, installation and maintenance.

The solar energy industry already exists to a certain extent in the county. The following solar energy companies operate in Lane County:

- Advanced Energy Systems (Eugene): Solar electric distributor and certified installer
- Solar Assist (Eugene): Certified solar electric installer
- The Energy Service Company (Eugene): Solar electric, solar water heating, solar pool heating and solar air heating distributor and certified installer
- Home Comfort (Eugene): Certified solar water heater installer
- Heliotrope PV (Eugene): Solar PV charge controllers for mobile applications
- K L Harrison (Eugene): Solar design and sales
- Oregon Solar and Water (Eugene): Certified solar water and pool heater installer

The Energy Outlet™, a resource center sponsored by Lane County utilities, also provides educational resources about solar hot water heaters, and directs residents to local distributors and installers. There are also several architect and engineering firms in Lane County that focus on "green building", on overarching term that includes passive solar design.

Solar energy applications in Lane County are visible, as well. Lane County contains the largest solar electric installation in Oregon. The Pacific Olive building in downtown Eugene had a 25 kW photovoltaic system installed on its roof in December 2002. The system's electricity is fed back into the Eugene Water and Electric Board (EWEB) grid. Through a special program, EWEB will buy the solar-generated power at a premium of 25 cents per kW for 10 years. The project also received support from the Oregon Office of Energy's Business Energy Tax Credit, which provided a tax credit equal to 35% of the installed project cost. Tom Bowerman, the building owner, believes that "If everything goes as planned, the return on investment should exceed 10 percent. In this investment market, that's good, and to be involved in green power is certainly a bonus.[45]

Despite the presence of solar installation and distribution companies, and the large solar electric installation in Eugene, no local corporations manufacture photovoltaics or solar water heaters. The technical expertise and material inputs for these industrial processes are quite significant.

Photovoltaic production, especially, requires a technologically-savvy workforce and chemical and circuitry inputs. Sony's recent departure from Lane County leaves no local technology production facilities to support a new PV production facility. However, this should not be a deterrent for local corporations interested in jumping in to the PV or solar water heater manufacturing process. Corporations can buy inputs from elsewhere in the Pacific Northwest. Also, local corporations can utilize "canned" production processes for solar industry veterans. For example, Spire Solar, the world's leading photovoltaic equipment manufacturer, sells turn-key photovoltaic production equipment. As the demand for solar energy increases in Lane County, the county will attract input businesses and local technological knowledge, making the production process more sustainable.

In order to lure solar manufacturers to Lane County, County and municipal governments must provide some sort of incentive. Numerous financial incentives for solar installation apply to Lane County residents and businesses. The Oregon Energy Trust offers several solar programs:

- Starting in May 2003, NW Natural residential customers became eligible for incentives up to $7,000 for solar electric or solar hot water systems.
- Businesses are eligible for a loan up to $20,000 for installation of approved solar systems.[46]

In addition to these incentives, the Oregon Office of Energy provides funding opportunities:

- Solar energy installations are eligible for a residential tax credit of $4.25 per installed Watt and a commercial tax credit of $2.25 per installed Watt.[47]
- The Office of Energy also provides a tax credit for residential solar hot water and space heating installations and a low-interest loan for commercial photovoltaic installations.

Also, the Eugene Water and Electric Board (EWEB) runs several incentive programs:

- "PV Eugene", a pilot project aimed to have 150 kW of solar electric capacity installed on Eugene are businesses. EWEB promotes this project by purchasing power from local business' photovoltaic panels at a premium for a designated time period.[48]
- The Bright Way to Heat Water program cash discounts and zero-percent loans on solar hot water and pool heaters, provided a qualified contractor installs the system.[49]

Federal tax laws also exist to provide businesses installing solar equipment a tax break. Eligible projects will receive a 50% first year bonus depreciation tax deduction.[50]

All of these financial incentives benefit the end user. Lane County could consider two options to incentivize local solar energy industrial development:

- Local tax break for corporations engaged in production, distribution or installation of solar energy technologies (See Arkansas tax credit below)
- Set a local Renewable Portfolio Standard: A Renewable Portfolio Standard is a commitment to obtain a certain percentage of the area's power from renewable energy. For example, in 1999, Austin, Texas, set a goal for 5% of its power to be generated from renewable sources by 2005.[51]

Lane County could bolster the local solar industry by forming a consortium of solar energy industry representatives and stakeholders. This consortium could promote existing end-user financial incentives, since increased utilization of these resources will create an increased

demand for local solar industry. Lane County could also considering partnership with the Million Solar Roofs Initiative (See Chicago Solar Partnership below).

Lane County would seem to have a major opportunity to grow the solar energy industry and help it become a significant force in the local economy. If just 10% of all single-family homes installed a solar hot water heater in their homes, cost savings would total $1.37 million annually with a 4-8 year payback period.[52] If just 5% of all single family homes in Lane County installed 1 kW of photovoltaic generating capacity, almost 7800 tons of carbon dioxide emissions would be prevented each year.[53] If the actions and recommendations suggested above are pursued, these outcomes are achievable.

Community Solar Energy Case Studies

Million Solar Roofs: Chicago Solar Partnership

In 1996, Chicago public schools, the City of Chicago, Chicago Transit Authority, Chicago Parks District, and the City Colleges of Chicago partnered as the Local Government Power Alliance. The following year, the U.S. Department of Energy launched the Million Solar Roofs initiative. This initiative aims to solar energy systems on one million U.S. facilities by 2010. The Local Government Power Alliance signed on as a Million Solar Roofs partner and eventually renamed themselves the Chicago Solar Partnership. The city of Chicago sees the partnership as an opportunity to:

- Improve the city's sustainability and reduce air pollution,
- Reduce energy costs at installation sites,
- Reduce the production costs of photovoltaics, while creating high-tech jobs,
- Enhance the curriculum at public schools with solar energy teaching tools, and
- Demonstrate commitment to a cleaner environment, while establishing Chicago as a center of technological innovation.

Since its inception, the partnership has installed 15 solar energy systems in Chicago. Many of these systems are located on public school grounds and the partnership makes a special effort to promote the technology as a teaching tool. The partnership also facilitated the siting of a new photovoltaic manufacturing facility in the city's impoverished West Side neighborhood.

Funding for the city's solar projects pours in from many sources. The Illinois Department of Commerce and Community Affairs has provided grants for 60% of the Chicago Public Schools solar installations. The partnership has received over $6 million from ComEd (the local electric utility) as a result of a Municipal Franchise settlement. IBEW-NECA electricians donate time for project installation. For more information: Chicago Solar Partnership, www.solarenergypartnership.com/contact

Arkansas Emerging Facilities Credit

Arkansas State provides state income tax credits for manufacturers of high tech and high growth energy technologies. The Arkansas Emerging Technology Development Act of 1999 aims to diversify the state's economic opportunities and attract higher paying jobs. The legislation provides a state income tax credit of 50% the amount to construct eligible renewable energy production or development facilities. Construction costs can include land purchases, infrastructure, renovation, facility improvements and equipment. Unclaimed tax credits can be carried forward for up to 14 years. For more information: AR Code 15-4-2101; Act 976 of 1999 and Act 1284 of 2001, http://www.dsireusa.org/dsire/library/docs/incentives/AR03F.htm

D. ZERO WASTE (WASTE FREE) PROGRAMS

A growing number of private firms, local municipalities, states and regions are adopting Zero Waste (also called Waste Free) programs. These programs seek to reduce waste to incinerators and landfills to zero. Zero waste initiatives go beyond the current recycling paradigm and close the resource use loop. Zero waste efforts usually have three integrated components. Public and private organizations seek to reduce the amount of energy and raw materials they purchase and consume. Steps are taken to ensure that the resources that are consumed are used at much higher rates of efficiency. Finally, the toxic and useable industrial by-products generated by the organization or community are fully sequestered and recirculated in technical cycles for reuse by industry while non-contaminated biological materials are recirculated into nature through composting and other strategies. To achieve these goals, waste materials must generally be separated into natural materials (i.e. food, wood, plant, water) and technical/chemical materials (e.g. industrial solvents, circuitry). In their most ideal form, zero waste initiatives are also zero emissions efforts.

Private and public-sector organizations can reach zero-waste goals by using a combination of proven waste-reduction methods:

- Clear Policies and Goals Committed to Achieving Zero Waste
- Process and Product Redesign
- Reduced Packaging
- Recycling and Reuse Programs
- Product Buy-Back Programs
- Extensive Composting
- Targeted Policy Shifting (Landfill fees, levies, bans, tax incentives)

Although the concept of zero waste appears to be a win-win situation, barriers related to policy and public perception prevent the concept's widespread adoption. Zero waste requires industry commitment from process inception. There is a perceived concern that a sustainable industrial process will cost more than a conventional process. In their book, *Natural Capitalism*, Hawken, Lovins and Lovins argue that whole-system engineering used from the beginning make sustainable industrial processes financially viable, as well[54]. The Grassroots Recycling Network, a strong proponent of zero waste management, identifies several additional barriers: "government subsidies favor extraction and waste", "the high cost of waste is hidden", "producers ignore responsibility for products' environmental costs", and "inertia of existing viewpoints and practices."[55]

On a local level, tipping fees provide a strong perceived disincentive for Zero Waste efforts. Local governments assess tipping fees for garbage disposal and use the fees to fund other local programs. Skeptics argue that increased recycling and reuse will decrease tipping fee funds available for other programs. However, with a policy shift, tipping fees can actually generate *increased* funds as a result of Zero Waste efforts. For example, a municipality may double tipping fees for large loads of compostable or easily reusable materials.

By rethinking the concept of waste and how they deal with it, communities imitate the cyclic characteristics of the natural world. Zero Waste in its purest sense means zero emissions, zero pollution and zero labor waste, as well as zero solid waste. When communities commit to zero waste goals, they aim for the ultimate level of sustainability.

Zero Waste initiatives also offer tremendous economic opportunities. As of July 2003, Lane County's unemployment rate topped 8%, well above the national average[56]. The Institute for Local Self-Reliance estimates that one job is created for every 15,000 tons sent to landfills, while seven jobs are created if that waste is composted or nine jobs if the waste is recycled (discounting additional production opportunities for recycled waste).[57] According to the Materials Future Foundation (California), rural areas with increasing unemployment from timber industry layoffs may benefit from the creation of a new manufacturing industry based on recycling and reuse[58]. In Auckland, New Zealand, where many local government councils have committed to zero waste goals, employment opportunities are rapidly growing.

A recent development in Japan shows that Zero Waste efforts are growing around the world. In September of 2003, the town council of Kamikatsu, Japan, located in Tokushima prefecture in the southwestern island of Shikoku, adopted Japan's first-ever Zero-Waste Declaration. The goal is to eliminate the need for incinerators and landfills and move the community towards safe and sustainable discard management systems. Called the "Kamikatsu Town Zero Waste Declaration," the policy states that, "to bequeath clean air, palatable water, and fertile earth for the children of posterity, the town of Kamikatsu shall abrogate waste incineration and landfills by the year 2020 to achieve zero waste." No municipality in Japan has ever adopted this kind of policy. Japan operates the most number of waste incinerators than any other country in the world today. It also holds the dubious distinction of having the highest levels of dioxins in the environment, a likely consequence of the government's burning policies.

IN adopting the policy, Kamikatsu embraces the Zero Waste approach seeks to eliminate waste, reduce the quantities and toxicities of materials used , and promote the reuse, recycling or composting of discarded materials.The mayor of Kamikatsu stressed the importance of the Declaration, saying that with it, "Kamikatsu hopes to send the message that Japan needs to Move away from its continuing addiction to expensive and polluting technologies which is leaving behind a wasteful and toxic legacy for future generations." He further added, "I want to help expand the network of zero waste municipalities not just in Japan but also worldwide. We hope that with our example, we would be able to encourage other municipalities to adopt the same policy."

Tables E(1) and E(2) describe how some communities and corporations have reduced their impact on the environment through zero waste initiatives.

.

Table E(1): Municipal Zero Waste Initiatives

Entity	Zero Waste Initiative	Impetus for Zero Waste Initiative	Zero-Waste Methods	Results: Environmental	Results: Economic
Canberra, Australia	In 1996, Canberra became the first government in the world to set a zero waste goal. Canberra aims to achieve zero waste by 2010	• Community consultation revealed that waste disposal was significant concern	• Community commitment with rewards and recognition • Avoidance and reduction: waste inventory, individual consumer choices, production redesign • Resource recovery: Resource Exchange Network • Residual Waste Management: changes in landfill charge structure • Creative Solutions: Research and development	• Between 1996 and 2002, waste recovery increased from 22 to 64%[59]	Economic data is not tracked
New Zealand	In 1999, the New Zealand Zero Waste Trust launched a campaign to urge local governments to enact a zero waste initiative, with an overall goal of zero waste by 2020 (one generation from goal-setting). As a result of the organization's success, the New Zealand Ministry of Environment embraced the challenge concept, and put the system in place in February 2003.[60]	• Continue New Zealand's reputation as a clean and green tourist destination • Export security • Import reduction • Reduce landfill emissions • Local economic development • Increased employment • Reduced liability • Technology transfer opportunities • Increased national pride[61]	• Overall structure: establishment of local zero waste councils (from $25,000 grants)[62] • Landfill fees, levies and bans • Separation at source • User pays systems • Extended producer responsibility • Deposit refund schemes • Advance disposal fee • Minimum Content Standards • Resource recovery infrastructure, parks and contracts • Facility standards and permits • Materials exchanges • Recycling targets for businesses • R&D grants/tax incentives • Branding systems for zero waste businesses • Mandatory corporate environmental reporting • Import standards • Deconstruction standards • Design for Environment (DFE) Assistance • Community and school	• Since 1999, 40 of the 74 New Zealand municipalities adopted zero waste[63] • Between 1999 and July 2002, Opotiki District Council reduced waste by 85%, Christchurch City Council by 20% and Kaikoura District Council by 52.1%[64]	• From 1999 through July 2002, participating communities created over 280 full-time and 17 part-time new jobs[65]

			education programs • Green procurement guidelines • Zero waste advisors • Precautionary principle • Measurement and monitoring • Community ownership of waste stream		
San Francisco, CA	After years of waste reduction goals, in 2002, San Francisco set goal of diverting 75% of the city's waste by 2010 and planned to establish a zero waste goal when the city reaches 50% diversion. In March 2003, the city enacted a resolution aiming to reach zero waste by 2020	• California set aggressive 50% diversion requirements, with a daily fine for non-compliance • San Francisco realized they could exceed the state's requirements and become a leader in Zero Waste • Alameda Co. set goal of 75% diversion but S.F. sends most of its landfill waste there – If San Francisco didn't reduce its waste, the city would need to find a new (& likely very costly) landfill site[66]	• Food scrap compost program • "Fantastic Three" curbside recycling program (curbside bins for paper, bottles and cans; food scraps, yard trimmings and compostables; trash) • Business participation in "Fantastic Three" (City provided discount on composting bin) • Community Recycler of the Year award program • Waste prevention and recycling grants to local businesses	• By 2002, diverted more waste than the city sent to landfills[67] • 300 tons of organic material are composted daily[68]	Data not yet reported
Seattle, WA	In 1998, the city first established waste reduction goals. In the city's 1998 Solid Waste Plan, Seattle adopted zero waste as its guiding principle, and aimed to recycle 60% of all waste generated in Seattle by 2008 without reducing waste reduction incentives (Broken down by sector: Commercial, 63%;	• Realized that waste reduction decreases costs associated with waste disposal	• Maximize curbside recycling • Create voluntary food waste collection • Provide recycling in public places • Expand environmental purchasing guidelines • Education and technical assistance • Exploring disposal rate incentives (i.e. garbage-by-weight billing)	• Surveys show that 90% of Seattle residents recognize importance of waste reduction[69] • In 1998, 43% of single-family households compost[70] • In 1997, 350 businesses attended waste reduction seminars[71] Note: No data is available for	• Identified $1.1 million of reusable items at recycling centers[72] Note: No data is available for achievements since 1998

	Single Family, 70%; Multi-family, 37%; Self-haul 39%)			achievements since 1998	
Toronto, Canada	In January 2001, Toronto created "Task Force 2010". The task force aims for 30% diversion by 2003, 60% by 2006, and zero waste by 2010.	• Landfills are closing and nowhere else nearby will accept the city's waste. A Michigan landfill will accept the waste, but the cost is prohibitive. • Requests by residents	• Organic materials curb-side pick-up • New anaerobic digestion facility for organics • Develop "take it back" system • Convert box recycling programs to bag programs • City-wide garage sales and giveaways • Curbside scrap metal collection • New opportunities for Styrofoam and wood recycle/reuse • Increased home composting education and support • Lowered bag limit for residential garbage	Data not yet reported	Data not yet reported

Corporations are also beginning to realize the economic and environmental potential of zero waste efforts. Table 2 describes the efforts of a handful of the hundreds of companies committed to eventually reducing waste to zero.

Table E(2): Corporate Zero Waste Initiatives and Efforts

Company	Zero Waste Initiative	Zero-Waste Methods	Results: Environmental	Results: Economic
Collins and Aikman, Dalton, GA	Zero manufacturing waste	• Zero landfill waste goals enacted in 1994[73]	• Zero landfill waste by 1998 (after four years)[74]	• Increased production by 300% without energy use increase[75]
Fetzer Vineyards, CA	General commitment to sustainability	• Greenhouse gas emission reductions by 100% renewable energy purchase • Comprehensive recycling plan • Water reuse strategy for landscaping • Environmentally-friendly packaging policy	• Reduced waste-to-landfill by 94% from 1990-2001[76] • Wine bottles now made from 40% recycled glass[77] • Case bottles made from 100% post-consumer waste • 100% acres are certified organic	• Production increased by 50% between 1990 and 2001[78] • Dump fee savings totaled over $150,000 from 1990-2001[79] • Insulated concrete wall in wine storage facility saves $5,000/month on energy bills[80]
		•	•	•
		•	•	•

Herman Miller, Inc., MI	Comprehensive environmental goals: energy savings, emissions reductions, green building, transport impact reductions and zero landfill goal by 1995	• Reduced transport packaging • Requires life cycle assessment of every new product (conducted by Design for Environment Team) • Ensures that process byproducts provided as inputs for other local businesses	• In 1999, eliminated 370 tons wood pallet waste, 270 tons of corrugated cardboard and 8 tons of packaging filler[81] • By the end of 1995, reduced landfill waste by 65%[82]	• In 1995, sustainability measures led to $500,000 in direct savings and avoidances[83]
Interface, Inc, Seattle, WA	Zero waste goal for materials, accounting, sales, human resources, etc.	• Pioneered "Evergreen Lease", which provides economic incentives for customers to return used carpet and "ReEntry Program", which requires used carpet to be reclaimed and then recycled, down cycled or repurposed • Re-engineering the production process • Product redesign – biodegradable carpet	• In 1999, a quarter of its production facilities diverted over 90% of their waste from landfills[84]	• During first three years of sustainability initiatives (1994-1997), it saved more than $50 million from reduced energy and material costs, and reduced waste[85]
Xerox Corporation, Rochester, NY	Waste-free factory policy	• Environmental purchasing • Environmental and energy efficient product specifications • Product take-back program • Hazardous materials reduction	• In 2002, products used 80% less energy, emitted and 81% less dust than in 1990[86] • In 2001, non-hazardous recycling rates topped 90%[87] • Air emissions from manufacturing were reduced 89% between 1991 and 2002[88]	• In 1999, they saved $47 million in reduction, recycling and reusing activities[89]

Zero Waste Opportunities in Lane County

Several organizations and events in Lane County have already set zero waste goals. The Oregon Country Fair, one of Lane County's largest tourist events, has a zero-waste goal for the event in 2003. The fair, which receives thousands of visitors, recycled or composted over 68% of its waste in 2002[90]. Cuthbert Amphitheatre, in Eugene's Alton Baker Park, instituted a "cups to compost" program for summer events in 2000. During one summer concert, attendees generated 1.5 cubic yards of compostable cup waste, which created about 80 lbs of compost additives[91] The University of Oregon's Comprehensive Environmental Policy includes several waste reduction and prevention activities: environmentally responsible purchasing, efficient resource use and minimized solid waste production. University of Oregon also has a recycled paper and wood policy, as well as comprehensive recycling, composting, deconstruction and office supply reuse programs. Eugene, Oregon's BRING recycling center provides a large reuse center for building materials, and MEECA provides art material reuse opportunities. Oregon's Department of Environmental Quality also recognizes the benefits of zero-waste goals: the department's 2000 strategic plan describes a vision of waste reduction and "eliminating the accepted belief in a trade-off between environmental and economic stewardship."[92]

Lane County could build on these programmatic successes by developing a county-wide zero waste initiative. As other communities have, Lane County could aim for "50% waste reducation to landfills by 2010" at which point the county could evaluate the effort and set a time frame for zero waste. Alternatively, the County could set a goal of"zero waste by 2010" and design programs to achieve it (See model resolution language in Appendix A). These goals are in-line with those set by other U.S. states and communities. Not only would approach encourage local businesses to set their own goals more quickly, it will also prepare the county for potential state-wide zero waste efforts. In California, counties and local governments initiated successful zero waste programs because the state had set aggressive zero waste goals with corresponding non-compliance fines. The Oregon DEQ has already embraced the concept of zero waste (see DEQ Strategic Plan 2000) and a goal and fine structure similar to California's is a future possibility. A county-wide zero waste initiative would also prepare Lane County for any future landfill bans or incinerator shut-downs, like those that have been occurring in Europe and Canada. Finally, a zero waste initiative fits in well with Lane County's clean and green image, and could be used to promote tourism as well.

To achieve these goals, Lane County may want to consider some new programs and several policy changes. Possible policy changes to assist Lane County's zero waste initiatives may include:

- Tipping fee schedule adjustment to pay for increased recycling/reuse infrastructure
- Landfill ban/fine for easily recycled or reused materials
- Tax incentives for corporations showing significant movement towards zero waste

In addition to these policy changes, Lane County could consider implementing several new programs:

- Expanded curbside composting program that includes kitchen waste
- Reward and recognition for commercial and individual zero waste heroes
- Expanded recycling opportunities in public facilities

- Increased community and school education, including recycling and reuse curriculum development and community workshops
- Annual county-wide free yard sale

Lane County businesses should be encouraged to aim for the same zero waste goals. When the county adopts these goals, and begins to adopt policy changes, local businesses will achieve a competitive advantage by having proactively adopted zero waste strategies. The economic incentives for corporations to engage in zero waste activities are strong (See Table E (2)). Interested businesses could develop zero waste strategies and become involved in U.S. EPA's WasteWise program, a voluntary program that helps corporations meet waste reduction goals[93].

Lane County government and business zero waste initiatives would lead to *new* business and job opportunities. For example, as composting needs increase as a result of a county-wide zero waste initiative, job and business opportunities in composting will also increase.

A zero waste initiative in Lane County would build upon already successful recycling and reuse activities, while create jobs and new businesses, and economically benefiting existing businesses. By setting aggressive goals, Lane County will see positive results quickly – "Because of its visionary endpoint, Zero Waste strategies lead to breakthrough improvements as opposed to small step-by-step actions."[94] These breakthrough improvements could help make Lane County a leader in waste reduction and overall sustainability.

Appendix One: Model Resolution for Zero Waste[95]

WHEREAS

- The placement of materials in waste disposal facilities, such as landfills and incinerators, causes damage to human health, wastes natural resources and/or wrongly transfers liabilities to future generations, and

- The elimination of specified types of waste for disposal, also known as disposal bans, will protect states from waste importation from other states and nations, and

- Consumers are currently forced to assume the high financial cost of collecting, recycling, and disposing of materials, and

- Tax subsidies for waste and virgin materials send the wrong economic signals to both consumers and producers, and

- A resource recovery based economy will create and sustain more productive and meaningful jobs, and

- Increasingly, U.S. and international governments and organizations are adopting the policy that the financial responsibility of collecting, recycling, and disposing of materials belongs with producers, and

- Producers should design products to ensure that they can be safely recycled back into the marketplace or nature, and

- Most types of waste streams can be easily eliminated through across-the-board minimum recycling content laws, the use of non-toxic alternatives in product design, and local composting facilities, and

- Recognizing that some materials are necessary for the public health and national security, in which case, storage is the only safe alternative, and

- Recognizing that voluntary recycling goals have not achieved waste elimination, and

- Government is ultimately responsible for establishing criteria needed to eliminate waste, so that manufacturers produce and businesses sell materials that can be safely recycled or composted,

THEREFORE, BE IT RESOLVED THAT

> [City/ County/ Organization] supports the creation of a Zero Waste Plan in order to eliminate waste to landfills and incinerators and pollution in the manufacture, use, storage, and recycling of materials by the year _____.

[1] McDonough W. and Braungart, M, *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press, 2002.
[2] Doppelt. B., *Leading Change toward Sustainability: A Change Management Guide for Business, Government, and Civil Society*, Greenleaf Publications, UK, 2003.
[3] McDonough W. and Braungart, M, *Cradle to Cradle: Remaking the Way We Make Things*, North Point Press, 2002.
[4] Ibid, Page 104.
[5] For more information see *Cradle to Cradle.*
[6] Schlarb, Mary. "Eco-industrial development: a strategy for building sustainable communities." Cornell University. Prepared for the U.S. Economic Development Administration. 2001. Web address: http://12.39.209.165/ImageCache/EDAPublic/documents/pdfdocs/1g3lr_5f5_5fschlarb_2epdf/v1/1g3lr_5f5_5fschlarb.pdf
[7] Schlarb, Mary. "Eco-industrial development: a strategy for building sustainable communities."
[8] Ibid.
[9] Devens Enterprise Commission Web site, Development Services page. http://www.devensec.com.
[10] Lowitt, Peter, land use administrator/director, Devens Enterprise Commission Development Services. July 28, 2003 correspondence.
[11]Devens Enterprise Commission Web site, Development Services page.
[12] Sustainable Industries Journal, Issue #9, October, 2003, Page 7.
[13] Information for this section of the research provided by Tom Osdobo of 4ePartners.
[14] U.S. Department of Energy's Energy Efficiency and Renewable Energy Program, BioPower, http://www.eere.energy.gov/biopower/basics/ba_bmo.htm
[15] U.S. Department of Energy's Energy Efficiency and Renewable Energy Program, BioPower, http://www.eere.energy.gov/biopower/main.html, Accessed July 2003
[16] Renewable Energy Policy Project FAQ
[17] Renewable Energy Policy Project FAQ
[18] Renewable Energy Policy Project FAQ
[19] U.S. Department of Energy's Energy Information Administration's State Energy Profiles (2000), http://www.eia.doe.gov/emeu/states/main_or.html
[20] U.S. Environmental Protection Agency, State and Local Climate Change Program, Climate Change Technologies: Biomass Energy, January 2000 http://yosemite.epa.gov/oar/globalwarming.nsf/UniqueKeyLookup/SHSU5BNJXH/$File/biomassenergy.pdf
[21] Options for Biomass, Renewable Energy Technology Characterizations, U.S. Department of Energy's Energy Efficiency and Renewable Energy Topical Report 1997
[22] Emerald People's District, Landfill Gas Project, http://www.epud.org/shortmountain.html
[23] Lane County, OR Food System Assessment Fact Sheet, Food for Lane County, Sarah Borron, January 10, 2003
[24] Assuming 385 kWh/cow/yr from: Barker, James C, 2001. Methane Fuel Gas from Livestock Wastes: A Summary, North Carolina State Extension Service, Publication #EBAE 071-80
[25] In Business, January/February 2003, "First Fries, Then Biodiesel for a Fast Start-Up", Dan Emerson p.10-12
[26] In Business, January/February 2003, "First Fries, Then Biodiesel for a Fast Start-Up", Dan Emerson p.10-12
[27] In Business, January/February 2003, "First Fries, Then Biodiesel for a Fast Start-Up", Dan Emerson p.10-12
[28] SeQuential Fuels Website, http://www.qfuels.com/index.htm
[29] Oregon Business Energy Tax Credit Program, http://www.energy.state.or.us/bus/tax/taxcdt.htm
[30] Oregon Residential Energy Tax Credit Program, http://www.energy.state.or.us/res/tax/taxcdt.htm
[31] Online Fuel Cell Information Center. <www.fuelcells.org.>
[32] U.S. Department of Energy. *International Energy Annual* (2000).
[33] E. Smeloff and P. Asmus, *Reinventing Electric Utilities: Competition, Citizen Action, and Clean Power* (Washington DC: Island Press, 1997)
[34] U.S. Department of Energy's Energy Information Association, Renewable Energy Annual Report, 2001, http://www.eia.doe.gov/cneaf/solar.renewables/page/rea_data/table10.html
[35] Florida Solar Energy Center, "Solar Water Heating: A Question and Answer Primer", David Block John Harrison, FSEC-EN-5 , Revised May 1997, http://www.fsec.ucf.edu/Solar/apps/sdhw/en5.htm
[36] U.S. Department of Energy's Energy Efficiency and Renewable Energy, "Solar Water Heating" Consumer Energy Information, DOE/GO-10096-050, FS 119, March 1996, Revised February 2000 http://www.eere.energy.gov/erec/factsheets/solrwatr.html

[37] U.S. Department of Energy's Energy Efficiency and Renewable Energy, "Solar Water Heating" Consumer Energy Information, DOE/GO-10096-050, FS 119, March 1996, Revised February 2000 http://www.eere.energy.gov/erec/factsheets/solrwatr.html
[38] "Natural Heating and Cooling: Passive Solar Design", David A. Bainbridge, Associate Professor Alliant International University, San Diego, CA
[39] Energy Center of Wisconsin Press Release, "Workshop Shows Benefits of 'Daylighting' Schools", September 19, 1999, http://www.daylighting.org/pubs/workshop_appleton.pdf
[40] Oregon Office of Energy's "Oregon Solar Electric Guide", 3/03, OOE CF-083, http://www.energy.state.or.us/renew/Solar/PV.htm
[41] Oregon Office of Energy's "Oregon Solar Electric Guide", 3/03, OOE CF-083, http://www.energy.state.or.us/renew/Solar/PV.htm
[42] U.S. Environmental Protection Agency's State and Local Climate Change Program, "Climate Change Technologies: Solar Energy", January 2000, http://yosemite.epa.gov/oar/globalwarming.nsf/uniqueKeyLookup/SHSU5BVR3A/$file/solarenergy.pdf?OpenElement
[43] National Renewable Energy Lab's "Solar Energy Fact Sheet", 4/00, http://www.nrel.gov/documents/solar_energy.html
[44] *NREL*, Report No. BR-520-30280: Second Quarter 2001, p. 7
[45] Oregon Office of Energy, "New Grid-Connected Solar System Largest in State", http://www.energy.state.or.us/renew/Solar/Eugene.htm
[46] Energy Trust of Oregon, http://www.energytrust.org
[47] Oregon Office of Energy's Solar Energy Incentives, http://www.energy.state.or.us/renew/Solar/Support.htm
[48] Oregon Office of Energy, "New Grid-Connected Solar System Largest in State", http://www.energy.state.or.us/renew/Solar/Eugene.htm
[49] Eugene Water and Electric Board's "The Bright Way to Heat Water", http://www.eweb.org/energy/brightway/index.html
[50] Oregon Solar Energy Industries Association, http://www.oregonseia.org/downloads/Federal_Tax_Incentives.pdf
[51] Solar Austin, http://www.seedcoalition.org/solaraustin/solaraus_takelead.htm
[52] Assuming average household spends 25% of utility bills on water heating and hot water heaters offer 50% savings at a minimum. Assumes typical U.S. family spends $1300 annually on energy, from: http://www.eere.energy.gov/consumerinfo/energy_savers/intro.html , Number of single family homes from 2000 U.S. Census Data, http://www.census.gov.
[53] Number of single family homes from 2000 U.S. Census Data, http://www.census.gov, Carbon savings from Solar Energy International Energy Facts, http://www.solarenergy.org/resources/energyfacts.html
[54] Hawken, Lovins and Lovins, *Natural Capitalism*, Little Brown and Company, 1999
[55] Grassroots Recycling Network Website, www.grrn.org/zerowaste
[56] Associated Press, August 9, 2003, "State unemployment rate drops in July" , William McCall
[57] The Jobs Letter: Special Issue Produced in Partnership with the Zero Waste New Zealand Trust, February 18, 2000
[58] The Jobs Letter: Special Issue Produced in Partnership with the Zero Waste New Zealand Trust, February 18, 2000
[59] 2002 Progress Report, Australian Capital Territory's "No Waste by 2010", http://www.nowaste.act.gov.au/publications/publications.html
[60] New Zealand Ministry of the Environment, March 2002, "Toward Zero Waste and a Sustainable New Zealand", http://www.mfe.govt.nz/publications/waste/waste-strategy-mar02
[61] Listed benefits from "End of Waste: Zero Waste by 2020", New Zealand Zero Waste Trust, May 2001 , www.zerowaste.co.nz
[62] "End of Waste: : Zero Waste by 2020", New Zealand Zero Waste Trust, May 2001 , www.zerowaste.co.nz
[63] New Zealand Zero Waste Councils, http://www.zerowaste.co.nz/default,nz.sm
[64] Zero Waste Council Report July 2002, http://www.zerowaste.co.nz/default,nz.sm
[65] Zero Waste Council Report July 2002, http://www.zerowaste.co.nz/default,nz.sm
[66] San Francisco Environment Resolution No. 007-02-COE - April 16, 2002, http://www.ci.sf.ca.us/sfenvironment/aboutus/policy/resolution/007-02.htm
[67] San Francisco Environment Press Release, December 12, 2002, Mark Westlund, "San Francisco Recycles More than it throws away" http://www.ci.sf.ca.us/sfenvironment/articles_pr/2002/pr/121202.htm

[68] San Francisco Environment Press Release, December 12, 2002, Mark Westlund, "San Francisco Recycles More than it throws away" http://www.ci.sf.ca.us/sfenvironment/articles_pr/2002/pr/121202.htm
[69] On the Path to Sustainability: Chapter 5, City of Seattle's 1998 Solid Waste Plan , http://www.cityofseattle.net/util/solidwaste/swplan/documents.htm
[70] On the Path to Sustainability: Chapter 5, City of Seattle's 1998 Solid Waste Plan , http://www.cityofseattle.net/util/solidwaste/swplan/documents.htm
[71] On the Path to Sustainability: Chapter 5, City of Seattle's 1998 Solid Waste Plan , http://www.cityofseattle.net/util/solidwaste/swplan/documents.htm
[72] On the Path to Sustainability: Chapter 5B, City of Seattle's 1998 Solid Waste Plan , http://www.cityofseattle.net/util/solidwaste/swplan/documents.htm
[73] Zero Waste Alliance, www.zerowaste.org
[74] Motavalli, Jim, "Zero Waste: No Longer Content Just to Recycle, Environmentalists Want Us to Reduce it to Nothing", E, the Environmental Magazine, March/April 2001
[75] Motavalli, Jim, "Zero Waste: No Longer Content Just to Recycle, Environmentalists Want Us to Reduce it to Nothing", E, the Environmental Magazine, March/April 2001
[76] Zero Waste Alliance, "Companies on the Path to Zero Waste: Fetzer Vineyards", http://www.zerowaste.org/publications/06d_Fetzer.pdf
[77] Fetzer Vineyards Environmental Philosophy, http://www.fetzer.com/about/stor_envi.html
[78] Zero Waste Alliance, "Companies on the Path to Zero Waste", http://www.zerowaste.org/publications.htm#case_studies
[79] Zero Waste Alliance, "Companies on the Path to Zero Waste", http://www.zerowaste.org/publications.htm#case_studies
[80] Zero Waste Alliance, "Companies on the Path to Zero Waste", http://www.zerowaste.org/publications.htm#case_studies
[81] EPA's WasteWise Update, Solid Waste and Emergency Response, March 2000, www.epa.gov/wastewise
[82] EPA's WasteWise Update, Waste and Emergency Response, March 2000, www.epa.gov/wastewise
[83] EPA's WasteWise Update, Waste and Emergency Response, March 2000, www.epa.gov/wastewise
[84] Grassroots Recycling Network, http://www.grrn.org
[85] Fishman, Charles, "Sustainable Growth – Interface, Inc", Fast Company, Issue 14 April 1998, p. 136
[86] "Environmental Health and Safety, A Record of Our Progress", Xerox Corporation, 2002
[87] "Environmental Health and Safety, A Record of Our Progress", Xerox Corporation, 2002
[88] "Environmental Health and Safety, A Record of Our Progress", Xerox Corporation, 2002
[89] "Zero Waste Turns Garbage into Savings", Environmental News Network, Jan 2, 2001, Suzanne Elston
[90] Bring Recycling Center (Eugene, OR) Newsletter, Summer 2002, p. 6, http://www.bringrecycling.org
[91] "Zero Waste in Action: Cuthbert Amphitheatre, Eugene, Oregon, Cups to Compost Project, Summer 2000", Grassroots Recycling Network, http://www.grrn.org/zerowaste/cuthbert.html
[92] OR Department of Environmental Quality 2000 Strategic Report, www.deq.state.or.us
[93] U.S. Environmental Protection Agency's WasteWise Program, http://www.epa.gov/wastewise/
[94] Zero Waste Alliance, http://www.zerowaste.org/case.htm
[95] Grassroots Recycling Network Model Resolution for Zero Waste, http://www.grrn.org/zerowaste/zwmodel.html